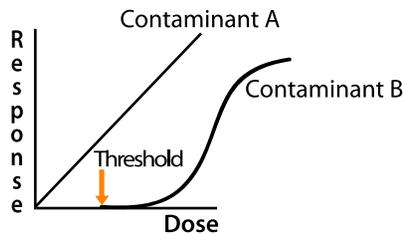


no exposures having “zero risk”. For each unit of increase in exposure (dose), there is an increase in the cancer response. See contaminant A in Figure 3. With these substances, different models are used to estimate or extrapolate the response at very low levels of exposure.

Figure 3. Dose-Response Curves. The threshold is a dose level under which there is no observed response.



(4) Risk Characterization

Risk characterization integrates the hazard identification, the exposure assessment, and the dose-response assessment to estimate the probability that a non-desirable effect or harm occurs in a particular human population. The risk characterization can be applied to a particular chemical substance (e.g., a solvent), a specific place or environment (e.g., the workplace), a selected city or population, or a specific activity (e.g., driving a car).

The risk characterization is presented or reported in several ways to illustrate how an individual or a particular population can be affected. If a substance does not cause cancer, it is reported as a hazard quotient (HQ). This fraction represents the relationship between a person’s dose of exposure and the corresponding reference dose (RfD).

$$HQ = \frac{\text{Average daily dose during exposure period (mg kg}^{-1} \text{ day}^{-1})}{\text{Dosis de Referencia (RfD) (mg kg}^{-1} \text{ dia}^{-1})}$$

Generally, if HQ value is equal or less than 1, the risk is not considered significant. Risk can also be reported as a Margin of Exposure (MOE) or risk of mortality (death). The following table gives examples of well known risks:

Risk	Risk of Mortality
Cancer from cigarette smoking (one pack a day)	1 : 4
Death in a motor vehicle accident	1 : 50
Homicide	1 : 100
Home accident deaths	1 : 100
Cancer from exposure to radon in homes	3 : 1000
Exposure to the pesticide aflatoxin in peanut butter	6 : 10,000
Diarrhea from rotavirus	1 : 10,000

Based on data in Wilson and Crouch (1987) and Gerba and Rose (1992).

Finally, the goal of the risk characterization is to summarize the key results of all the assessments without having to repeat all of the evaluation process. The risk characterization has to be done in a clear, consistent, and rational manner. Generally, the results will also include the impact to the subpopulations, the uncertainty and the type of investigation recommended or future actions suggested to improve the risk characterization.

Do you want to know more?

En Inglés:

- US EPA Integrated Risk Information System www.epa.gov/iris
- US EPA Guidelines for Exposure Assessment. Risk Assessment Forum, Washington, DC. <http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=15263>
- US EPA Framework for Cumulative Risk Assessment. Risk Assessment Forum, Washington, DC. <http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=54944>
- CDC. Third National Report on Human Exposure to Environmental Chemicals. <http://www.cdc.gov/exposurereport/>
- SOT 2007 CE Course. Fundamentals of Human Health Risk Assessment with a Case Study Approach. Charlotte, NC.
- Environmental and Pollution Science. Second Edition. Ian L. Pepper, Charles P. Gerba and Mark L. Brusseau. Chapter 14 – Environmental and Pollution Science.

In Spanish:

- Peña, C.E., D.E. Carter, and F. Ayala-Fierro. 2001. Toxicología Ambiental: Evaluación de Riesgos y Restauración Ambiental. <http://superfund.pharmacy.arizona.edu/toxamb/>



www.superfund.pharmacy.arizona.edu

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Have you ever been asked if you are willing to take the risk of, for example, a ride on a motorcycle, have surgery, or invest money in the stock market? Risk is the possibility that you might suffer an adverse effect or that something undesirable might happen. What is the possibility you might have an accident riding a motorcycle, that the surgery does not go well or goes as expected, or that you might lose all your savings in the stock market?

Risk Assessment is the process of estimating the probability of an event happening and the probable magnitude of its adverse effects over a specific period.

The Risk Assessment Process consists of four basic steps:

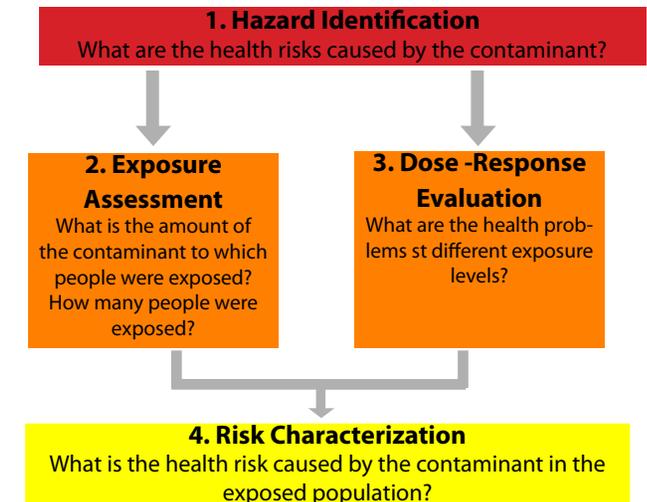


Figure 1. Four Basic Steps of the Risk Assessment Process

(1) Hazard Identification

The first step is to define the hazard and nature of harm. A hazard is a property or situation that, under certain circumstances, can cause harm to your health. That is, the hazardous effect or harm that substances or agents are causing, or could cause, must be identified and documented first.

Substance / Agent $\xrightarrow{?}$ Effect / Hazard



Risk Assessment

Certain diseases occur as part of the normal aging process. However, exposure to some substances can increase the incidence of some diseases. Once the hazard has been identified, then it can be determined if the exposure to certain substances or agents can increase the incidence of an undesirable effect (e.g., disease).

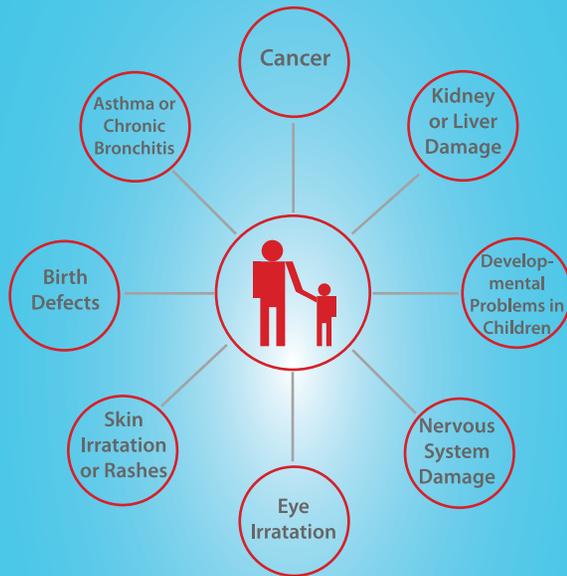


Figure 2. Possible long-term and short-term effects and symptoms caused by exposure to certain hazardous substances.

This information can be obtained through various types of studies. There are epidemiological studies (monitoring of human populations) that help determine if the occurrence of a disease is due to exposure to a specific substance. For example, it has been well documented and is well known that long-term arsenic ingestion can cause cancer. Another common type of study for hazard identification is done using animals in laboratories or in vitro (test tubes) since it is not always possible to experiment on humans.

(2) Exposure Assessment

The exposure assessment determines the type, intensity, frequency, and duration of the human exposure to a specific substance or agent.

Exposure to a contaminant can occur through ingestion, inhalation, or skin absorption. The person or population exposed to a substance or agent is known as the “target population”.

In order for a person or a population to be exposed, the hazard has to be present in the same dimension (time and place). Only in the right dimension, can the person or population be affected. This means, if there is hazard present but there is no exposure, then there is no risk. For example, if a building collapses with no one inside, then the risk that someone was hurt is zero.

$$\text{Risk} = \text{Hazard} \times \text{Exposure}$$

In some cases the target population can include particularly susceptible groups of people such as children, the elderly or pregnant women (subpopulations). The parameters to analyze will always be fixed based on the target population.



Epidemiological questionnaires are used to evaluate the risk of a target population. It is also possible to determine (monitor and measure) the concentration of a substance in the environment or contact point (water, air, food) and to use mathematical models to evaluate the area where the exposure takes place.

(3) Dose-Response Assessment

The fact that a person has been exposed to a particular substance does not necessarily mean that he/she will present any symptoms or develop a disease. It is necessary to know if the amount of exposure can cause any harm. This can be determined by assessing the response to the dose of exposure.



When a substance is ingested, lead for example, the substance is distributed to different organs inside the human body (e.g., kidneys, liver, etc.). The organ that receives a dose of substance responds with an effect. Different models of investigation are used to measure these effects.

The dose-response relationship (or curve) for a particular contaminant describes the association between the exposure and the observed response (health effects). These curves estimate how different levels of exposure to a contaminant change the probability and severity of the health effects. As with the hazard identification process, scientists use results of animal and human studies to establish dose-response relationships.

For substances that do not cause cancer, the Environmental Protection Agency (EPA) has established the Reference Dose (RfD). The RfD is the estimated daily dose that is likely to pose no appreciable risk to human populations, including sensitive groups such as children. See threshold on Figure 3.

For substances that can cause cancer, the dose-response relationship is evaluated differently. For these substances, the EPA assumes that there are

