Risk Assessment Principles

Assoc. Prof. Dr. İlker BÜYÜK

Learning Objectives

By the end of this lesson, you should be able to:

- Describe how severity of occupational hazards is expressed
- Illustrate how hazard severity and exposure are combined to characterize risk
- Identify strategies to assess worker exposures to potential hazards
- Explain approaches to managing risk once it has been characterized
- Recognize uncertainties associated with risk management

Risk: Definition

- What is risk?
  - The likelihood of injury, disease, or death
- What is environmental risk?
  - The likelihood of injury, disease, or death resulting from human exposure to a potential environmental hazard

Risk

Scientists and engineers typically conceptualize risk as an objective, quantifiable variable that can be given a numerical value.

Expected Risk = **The severity of the effect (Hazard)** x **The probability of effect (Exposure)**

Components of RiskAssessment

- Hazard characterization
- Dose-response evaluation
- Human exposure evaluation

Risk Assessment Step 1: Hazard Characterization

Hazard characterization is the subjective, scientific evaluation of

- Animal data
- In-vivo data
- Human data
- Structure-activity relationship data

to produce a comprehensive judgment about the potential human health effects arising from exposure.

6

Hazard Characterization

- A critical first-step in the Risk Assessment Process
- ALWAYS REQUIRES DATA

- Is inclusive of all health end points, from irritation to cancer; can include PB-PK (physiologically based pharmaco-kinetic) studies
- It's an expert process, typically involving toxicologists, epidemiologists and other professionals
- Sometime it results in a "cancer classification"

7

Hazard Characterization

LD_{50} (Lethal Dose 50%) - Basic measure of hazard

- Median lethal dose in test animals
  - 1/2 of test animals die
- Which is more toxic?
  - LD_{50} = 1 mg/kg
  - LD_{50} = 5 mg/kg
- Crude measure but allows comparisons

Example: Hazard Characterization

Examples of LD_{50}s (oral, rat)

- Sucrose = 29,700 mg/kg
- Sodium Chloride = 3,000 mg/kg
- Caffeine = 192 mg/kg
- Parathion = 2 mg/kg

Hazard Characterization: Process Issues

- Data Sources
  - Quality and Adequacy Assessment
  - Individual studies
  - Entire databases
- Review and analyze toxicity data
- Determine Weight Of Evidence
- Relevance for humans

Examples of Hazard Characterization

- OSHA preambles for health standards; supporting risk assessments
- NIOSH Criteria Documents
- ACGIH TLV Documentation; cancer classification
- IARC reviews/cancer classifications
- ATSDR Toxicology Profiles
- EPA Specific Chemical Reviews; cancer classification.
- EPA IRIS (Integrated Risk Information System) Database

11

Hazard Characterization Data

- Human Studies
  - Clinical studies
  - Epidemiology
- Animal Toxicity
- Supporting Data

Epidemiological Studies

The relevance of epidemiology is clear, but it can be difficult to assess causality

- Humans do not live in controlled environments
- Assessing past exposures can be difficult
- There are often confounding exposures
- Many occupations involve mixed exposures
- Long latency periods

Epidemiology finds **associations**, the question is **causality**

Hazard Characterization and Human Epidemiology

- Strength of Evidence Assessment
- **Sufficient evidence** generally means that
  - A causal relationship has been established and
  - Chance, bias, and confounding could be ruled out with reasonable confidence

Animal Studies

Three major areas of focus:

- Endpoints
- Life stages
- Duration

Animal Toxicity Studies

Study Types and Durations

- Acute (14 Days)
- Subchronic (13 weeks)
- Chronic (2 years)

Animal Studies

The strengths and limitations of animal studies complement those of epidemiology

- Exposure is clearly defined
- Confounding factors can be controlled, so causality can be attributed to a specific agent
- Small risks can be investigated through high-dose testing
- Results are available in < 3 years

Hazard Characterization and Animal Studies

- There is sometimes the question of whether the experimental results are relevant to humans
- Bioassays demonstrate causality, the question is relevance
- Sufficient evidence generally means that positive results have been replicated in independent studies

Data from Mechanistic Studies

- Mechanistic studies seek to “fill in the blanks” between exposure and the occurrence of health effect
- Knowledge of intermediate steps can provide information about relevance
  - Is the mechanism in experimental animals likely to be operating in humans?
  - Is the mechanistic evidence weak, moderate, or strong?
- Allows epidemiologic and experimental studies to focus on target cells and tumor precursors

Hazard Characterization

- Ends with the subjective-qualitative evaluation of the potential for human health risk if exposure occurs.
- It seeks to identify WHAT will occur.
- It is not a dose-response assessment, which is typically handled separately (and will be discussed next).