

Risk Assessment and Exposure in Epidemiology

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Reasons to Undertake Risk Assessment for Chemicals

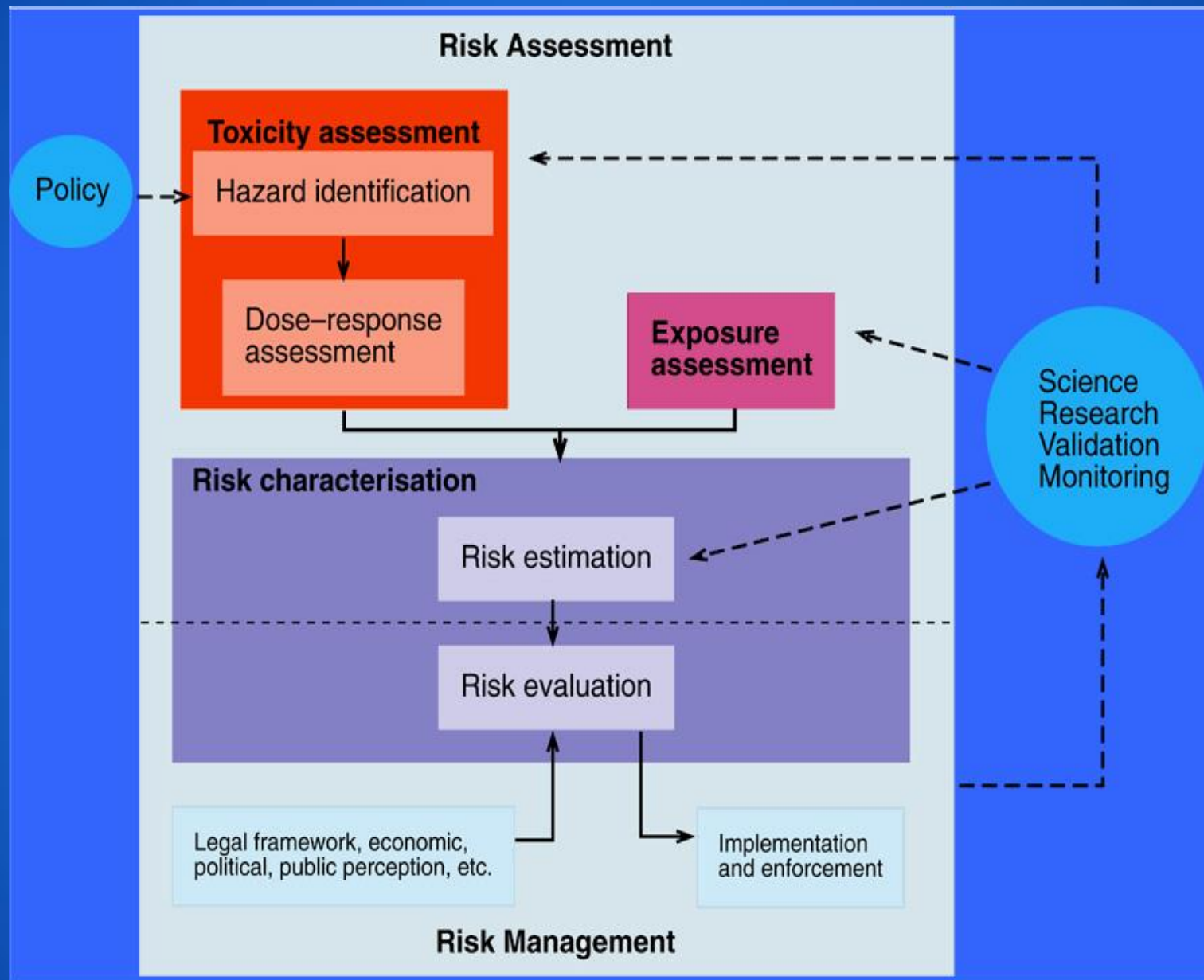
- to find or predict causes of ill-health in the population or particular groups (children, workers, women, etc.)
- to see if there are changes in health (good or bad) with occupational, environmental or consumer exposure changes
- to help set “acceptable” standards for environmental contaminants (air, food, water)
- to reassure people that government/industry scientists have adequately protected them
- to comply with regulations (e.g. REACH)

Principles of Risk Assessment

- risk assessment is not risk management
- risk assessment is:
 - hazard identification (what)
 - exposure assessment (who)
 - risk characterisation (how much)
- all these above may contain uncertainties and require assumptions or statistical treatments
- risk management is about responding to the risk assessment:
 - prevention of exposure
 - reduction of exposure
 - balancing risk against cost
 - explaining to public groups
 - making political decisions

Role of Government and Scientists

- must respond to pressure from public, media, trade unions, etc.
- risk reduction produces “level playing field” and drives industry to use latest control technology
- avoid being over-responsive to pressure groups to over-regulate some hazards (also converse applies)
 - **reduction in credibility of government/scientists**
 - **excessive costs and burdens of industry**
 - **restriction of freedom of individuals**



Four stage evaluation process

1. Hazard identification

- Review all toxicological and human data

2. Hazard characterisation

- Dose-responses (human & animal) as well as interspecies variability in susceptibility & mode of action

3. Exposure characterisation

- Estimating (or modelling) human exposure

4. Risk characterisation

- Summarising all the above stages & developing an approach for genotoxic or non-genotoxic substances

Exposure Assessment

“is the measurement, estimation or prediction of intake or exposure to a chemical, in terms of magnitude, duration and frequency, for the general population, for sub-groups of the population, or for individuals.”

Source Characterisation Release:

“is the measurement made to characterise the rate of release of agents into the environment from a source emission such as an incinerator, landfill, industrial or municipal facility, consumer product, etc.”

Exposure Characterisation

- Most important part of exposure assessment
 - **brings together assessment (data and estimates) with discussion, analysis and conclusions**
 - **allows key assumptions and uncertainties to be expressed**
- Leads to balanced representation of all relevant available data and relevance to health effects.

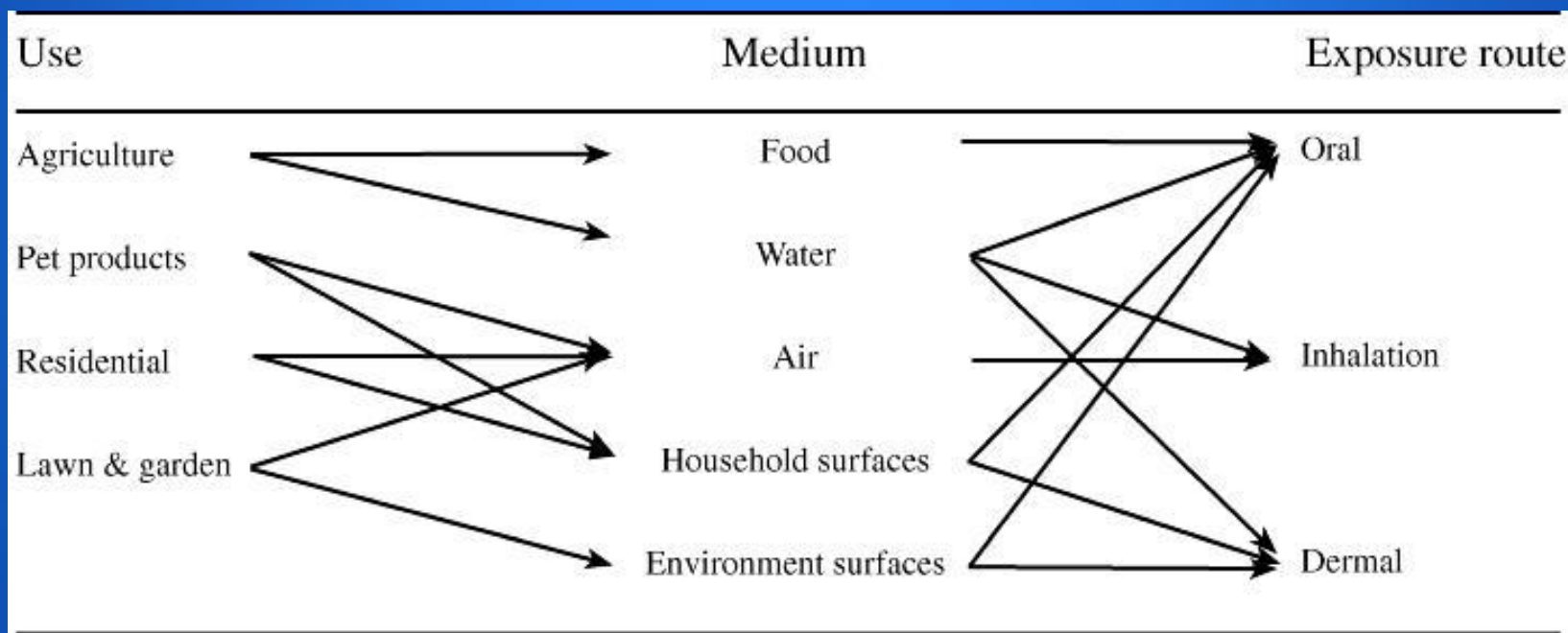
Key Features of Exposure Characterisation

- purpose, scope, level of detail and approach of exposure assessment (including key assumptions)
- estimates of exposure and dose by pathway and route for individuals, sub-groups or whole populations in a manner appropriate for the intended risk characterisation
- evaluation of the overall quality of the exposure assessment and the degree of confidence the authors have in the estimates of exposure and dose, and the conclusions drawn
- summary and interpretation of data and results that can be applied, along with characterisation of other risk assessment elements, to develop a risk characterisation.

Nature of Exposure Assessment / Characterisation

- can be extremely complex problem
- need to consider all sources of possible release
- need to consider all pathways/media:
 - **air**
 - **water**
 - **food**
 - **dermal contact**
- need to consider particular groups/individuals
- need to consider expense and practical considerations

Environmental Pesticide Exposure



Why Measure or Estimate Exposure ?

- Many good reasons:
 - compliance with standard
 - setting new standards
 - looking for peaks
 - estimating averages (days, months)
 - looking at trends (air/water pollution)
 - research (prospective, retrospective, etc.)

Purpose and Practicability of Exposure Assessment

- Research or other key questions decide type of exposure method:
 - Who? (population, sub-population)
 - How long? (days - years)
 - Metric? (fibres/ml, mg/m³, ppm)
 - Precision? (ever / never)
 - When? (now, in the past)

Research Question

- Hazard + Exposure = Risk
 - is it whole population?
 - a sub-population? (children, elderly)
 - is it the right hazard?
 - how much accuracy do you really need?

Assessing Exposure for Research Purposes

- General issues to consider before assessing exposure
- Summary of common exposure-measurement methods
- What are the implications of errors in exposure?
- How do you reduce errors?

Exposure Measurement Relevant to Health (1)

- Causative/associated agents may produce:
 - Physiological changes
 - Actual disease
 - May be a confounder of something else
 - May modify another agent
 - May be unrelated, but associated with outcome to be studied

Exposure Measurement Relevant to Health (2)

Key features of exposure - Remember:

1. Exposure is not the same as uptake
2. Time relationship of exposure to disease outcome (now – then)
3. Exposure is only a surrogate of what you really want.

Practical Aspects of Exposure Assessment

- Which agents should you measure?
- What is the most appropriate way of measuring?
- Is the “average time” best related to your research question?
- What is the human duration of exposure of concern?
- Can your sampling strategy characterise exposure across individuals/groups over time and locations?
- What statistical approaches are you going to use to relate exposure to effect?

Different Ways of Measuring Exposure

- **Exposure**

- Exposure in air [breathing zone]
[general air]
- Exposure in drinking water [x2 litres / day]
- Exposure via food [diet survey]
- Exposure through skin [contact x uptake]

- **Uptake**

- Biological fluids [blood/urine]
- Biological target tissues [target cells]
- Biomarkers [DNA adducts]

Exposure Metrics

- Ever – never exposed [simplest]
- Duration of living in location / employment
- Total cumulative exposure [activity diaries]
- Average exposures [one week? one year?]
- Worst days' exposure [time series]
- Highest-peak exposure [acute effects]

Classification of Exposures

- Personal attribute or environmental exposure?
- Subjective or objective data?
 - Questionnaires
 - Expert judgement
 - Time activities diaries
 - Actual chemical analyses
- Present or past experience
 - Relate to type of health effect
 - Acute or chronic condition

Methods of Exposure Measurements

- Direct
 - Area sampling
 - Personal monitoring
 - Biomonitoring / biomarkers
- Indirect
 - (micro) Environmental monitoring
 - Personal interview
 - Questionnaire
 - Time activity diary
 - Exposure modelling

Assessment of Personal Exposure to Air Pollution

- air pollution is known to cause acute and chronic ill-health effects
- it is often measured by fixed-site monitoring stations (FSMS's)
- good exposure assessment required for:
 - **research on health effects**
 - **setting air quality standards**

Personal Exposure to Pollutants

- People move between various micro-environments (indoors and outdoors)
- Most people spend 90% of time indoors
- Interaction between temporal and spatial variation in air pollution concentrations and time-activity of people mean all individuals are unique
- Need to consider frequency distributions of exposures within populations

Sources of Air Pollution

- Vehicle emissions
- Factory emissions
- Power stations
- Types of pollutant can be gaseous (ozone, CO₂, CO, sulphur dioxide, oxides of nitrogen, benzene, PAHs) or particulate (carbonaceous, fine salts, lead, other metals, etc.)

Exposure Measurements Need to be Related to Health Outcomes

- Acute
 - asthma attacks
 - “heart attacks”
 - acute bronchitis
- Chronic
 - lung cancer
 - chronic bronchitis
- For research or standard setting

Means of Determining Exposure to Air Pollutants

- Exposure analysis approaches (direct or indirect)
- Direct
 - personal monitoring
 - biological markers (PBPK models)
- Indirect
 - environmental monitoring
 - models
 - questionnaires
 - time-activity diaries

Exposure Documents

- Guidelines for good exposure assessment practice for human health effects of chemicals

<http://ieh.cranfield.ac.uk/ighrc/cr10.pdf>

- Current approaches to **exposure modelling** in UK Government Departments and Agencies

<http://ieh.cranfield.ac.uk/ighrc/CR15.pdf>