Evaluating Environmental Health Concerns

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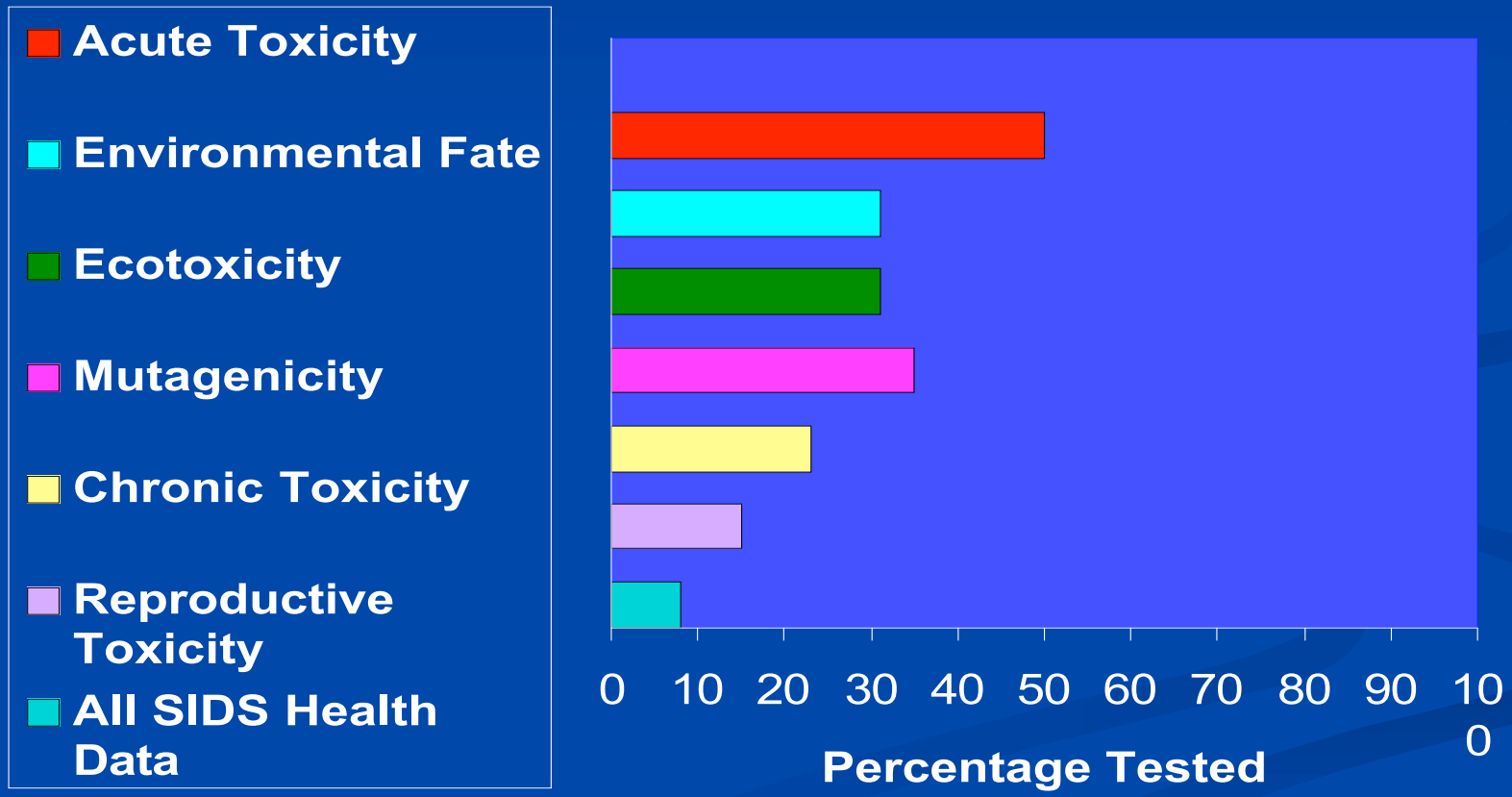
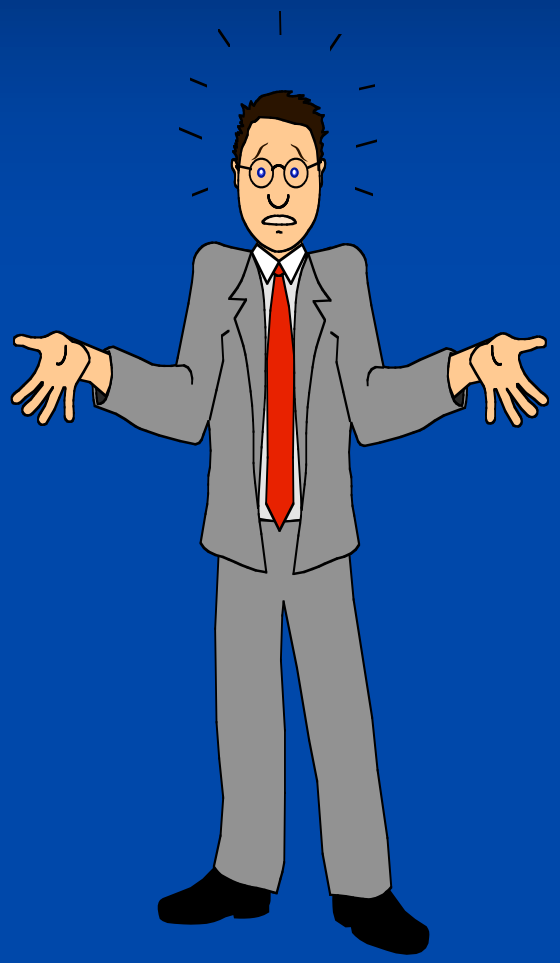
How to Tell if You're Nuts

- "There's no evidence of an association between…."
- "There are no data to suggest.
- "This study shows no link…."

Hazard Data Available for U.S. High Production Volume Chemicals

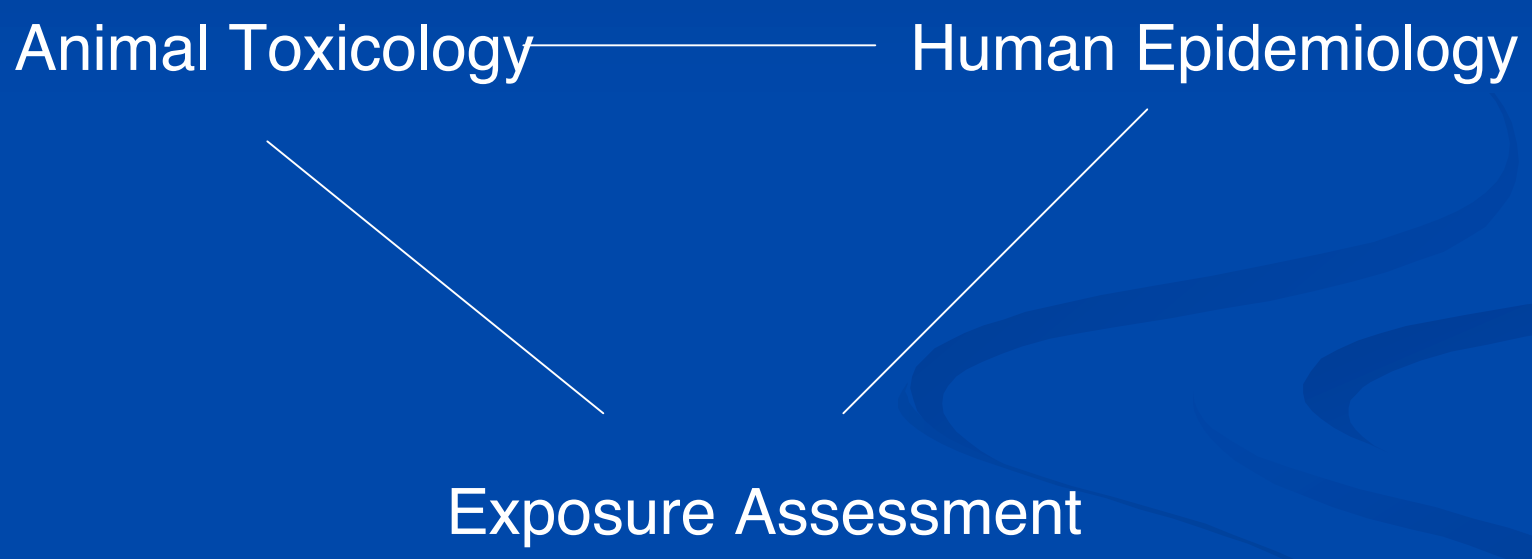


Why Are There Often No Clear Answers?



1. Suppression or distortion of information
2. Poor study design or execution
3. It is not scientifically possible to provide clear answers under the circumstances

Sources of Information



Problems with Current Animal Toxicology Testing

- Animals are human age-equivalent of 7-70
- One chemical at a time
- Genetically homogenous animals
- Healthy, well-nourished animals
- High doses / crude endpoints
- Very expensive and slow to do well

Problems with Current Human Epidemiology

- Difficulty measuring exposure
- People are exposed to mixtures
- Hard to control for all relevant exposures
- Gene-environment interactions
- Long latency of disease
- Rare diseases
- “Small” effects

Morgenstern and Thomas, Environ Health Perspect 101(Suppl 4):23-38, 1993

Epidemiology:
Research Challenges

- Bias toward finding an effect:
  - “Texas Sharpshooter”
  - Recall bias
  - Multiple comparisons
- Bias toward the null (not finding an effect):
  - Small sample sizes (low power)
  - Exposure misclassification
  - Lumping diseases together (effect misclassification)
  - Timing/latency uncertainties

Risks of Error

- We will never know everything
- Errors are inevitable
- Is it worse to miss an association which exists or to claim an association which does not?
- Less a scientific question than a question of ethics...

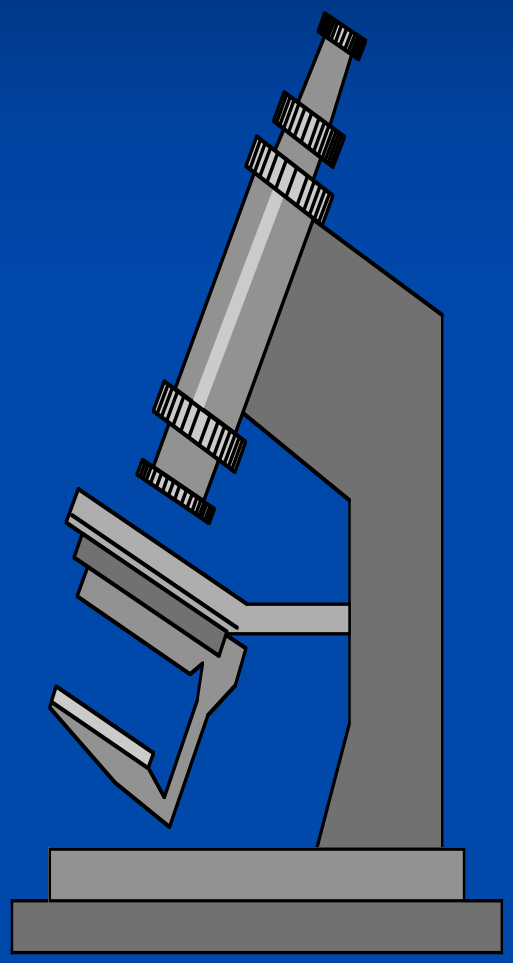
“Type I” Error

- Claiming an association which doesn’t exist
- Why it’s a problem:
  - Can send science off on a dead-end inquiry
  - Embarrassing for the researchers
  - Can result in regulation, anxiety, money loss that turns out to be unjustified
- Traditionally considered ‘worse’ than Type II error
- Guarded against by setting α at 0.05

"Type II" Error

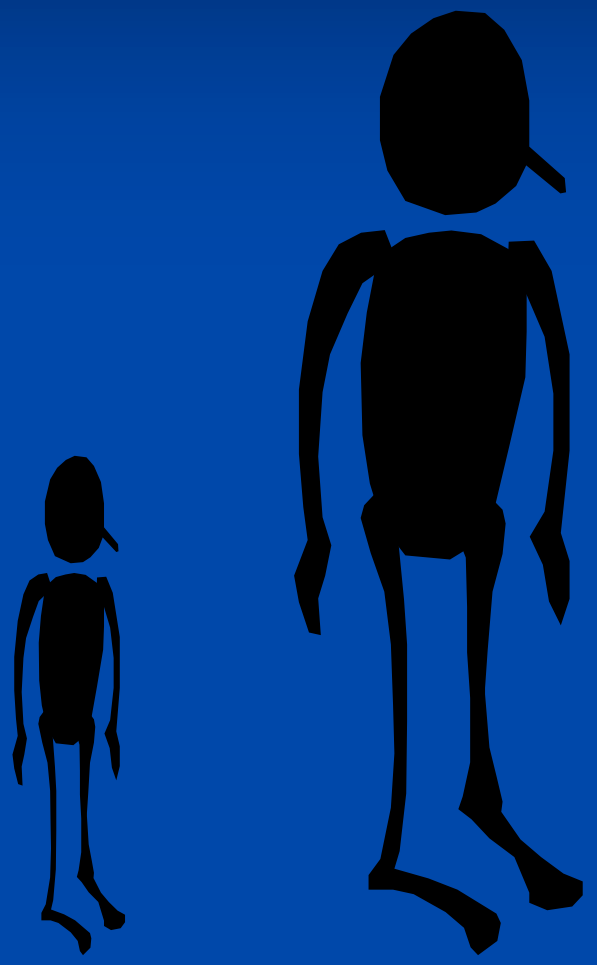
- Failing to identify an association which really exists
- Why it's a problem:
  - May allow continued exposures to a health threat
  - May result in preventable morbidity or mortality
  - May ultimately create significant social costs
- Generally considered **less** important than Type I error
- β conventionally set around 0.20 or not explicitly considered

The Scientist



- Is it statistically significant?
- Is it biologically plausible?
- Are the traditional criteria for causation fulfilled?
- What is the weight of the evidence?

The Public



- What are the implications to my family and community?
- Would you live in this community? / drink the water?
- Suspicion of cover-up

Causation and Decisionmaking:

"All scientific work is incomplete -- whether it be observational or experimental. All scientific work is liable to be upset or modified by advancing knowledge. That does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action it appears to demand at a given time."

Hill, Proc Royal Soc Med 58:295-300, 1965

What Not to Do

- Accept lack of evidence as equivalent to lack of harm
- Be intimidated by their scientists
- Fall into the ‘study it to death’ trap
- Demand a community health study

What to Do

- Learn whether/how the chemicals can get into our bodies
- Collect exposure data or environmental sampling
- Identify the groups that may be at greatest risk
- Gather what information is known about the chemicals
- Tell the personal stories (case reports)
- Push for precautionary action to protect health

Chemical Contaminants in Water

- Hydraulic fracturing fluids
  - Solvents (benzene, other aromatics, alcohols, glycol ethers, petroleum aliphatics)
  - Naphthalenes
  - PAHs

How would these enter your body?

Human Exposure to Solvents in Water

- Less than 50% from oral ingestion
- More than 50% from showers and other hot water vapor sources
  - Of that...
  - 50% is contributed by dermal absorption,
  - 50% by inhalation

(Jo et al, Risk Anal, 1990, Beavers et al, JOEM, 1996, Wiesel et al, EHP, 1996)

Routes of Exposure

- Ingestion
  - Portal venous system to the liver
  - Extensive first-pass metabolism
    - Worse if hepatotoxic or metabolite is active
- Inhalation or Dermal
  - Bypass liver directly into systemic circulation
  - Higher dose to placenta
    - Worse if toxic to fetus or other organs and if compound itself is toxic

(Wiesel et al, EHP, 1996)

Environmental Fate is Critical

- Solubility
- Volatility
- Persistence
- Bioaccumulation potential
- Dermal and placental penetration

Children are Often More Susceptible

- Developing brain and nervous system more susceptible to environmental exposures
- Pound for pound, children take in more air, food, and water than adults
- Skin is more permeable
- Intestinal absorption of contaminants is greater

Child's Environment Differs from Adult

- First environment - transplacental exposures
- Exposures from breast feeding or bottle feeding
- First years of life
  - close to the ground; spend a lot of time on the floor
    - exposure to dust and soil
    - carpets (a reservoir for contaminants)
    - heavy vapors in low lying layers of air
  - hand to mouth activity

Children and Drinking Water

- Children drink 2 $^1/_2$ times more water than adults as a proportion of body weight
- A bottle-fed infant consumes $^1/_7$ of its body weight in water every day
- That's the equivalent of 3 gallons of water per day for a 70 kg man

(WHO, 1986)

Precaution in Science

"The present state of our planet results from society having consistently preferred to guard itself against the first type of error. I suggest that type 2 errors would, in the long run, have proved less costly in social and economic terms."

Beland, Nature Can. 17(4):29-36, 1988


DIESEL
OPEN 24 HOURS
2V08


KEEP OUT

MSDS

- http://www.ilpi.com/msds/index.html

  -Product Identification
  -Manufacturer Information and Phone Number
  -Physical and Chemical Characteristics
  -Health Hazards
  -First Aid
  -Firefighting Measures
  -Handling, Storage, and Transport Information

User beware! No enforcement of accuracy!

Other Resources

- www.atsdr.cdc.gov/toxfaq.html
  - 2-page toxicity summaries from CDC
- www.atsdr.cdc.gov/toxpro2.html
  - Longer, detailed toxicity info from CDC
- toxnet.nlm.nih.gov
  - Place to search for scientific articles on a topic
- www.scorecard.org
  - Place to search for info about chemical releases from a site or in an area

Clinical Information and Consultations

www.aoec.org

Association of Occupational and Environmental Clinics

www.aoec.org/PEHSU.htm

Pediatric Environmental Health Specialty Units