Risk Assessment of Air Contaminants

South Central Fresno Community Steering Committee Meeting
May 8, 2019

HEATHER BOLSTAD, PH.D.
STAFF TOXICOLOGIST
OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
OEHHA Assessments Support CalEPA Environmental and Public Health Activities

**CalEPA Mission:**
To restore, protect and enhance the environment, to ensure public health, environmental quality and economic vitality.

**OEHHA Mission:**
To protect and enhance the health of Californians and our state’s environment through scientific evaluations that inform, support and guide regulatory and other actions.
Outline

- Background: risk, toxicity, and exposure
- How OEHHA determines toxicity
- Factors that influence toxicity
- How OEHHA determines Health Guidance Values for use in estimating risk
- Health concerns associated with some of the chemicals being measured
- How risk is determined from air monitoring data
- How do improvements in air quality affect health?
Risk = Toxicity \times Exposure

- How dangerous is the chemical?
- Does chemical contact or enter our body?
- Health Guidance Values
- Air monitoring data
What is Exposure?
How do we determine the toxicity of chemicals?

OEHHA develops benchmarks for toxicity called Health Guidance Values:

*Noncancer: Reference Exposure Levels (RELs)*

The amount of chemical in the air that is not likely to cause noncancer health effects (like asthma) even in sensitive populations like children and pregnant women.

*Cancer: Unit risks or cancer potency factors*

Describe increase in cancer risk per unit of exposure.
What influences toxicity?

• Amount

• Length of exposure (time)

• Sensitivity

https://www.meadindoor.com/for-physicians/
Health effects can become more serious as the amount someone is exposed to increases..

![Graph showing the relationship between the amount of alcohol consumed and the seriousness of the effect.](https://science.education.nih.gov-supplements/webversions/Chemicals/guide/lesson3-1.html)
Toxicity depends on the amount of time someone is exposed to a chemical

OEHHA develops Reference Exposure Levels for specific amounts of time

- **Brief exposure (acute):** occasional 1-hour exposures
- **Moderate exposure:** repeated 8-hour exposures over a significant fraction of a lifetime
- **Constant exposure (chronic):** continuous exposures from 1 year to a lifetime

https://accesspharmacy.mhmedical.com/content.aspx?bookid=2462&sectionid=194918140
More people are affected as the amount of chemical they are exposed to increases

People differ – some are more sensitive than others (like children and pregnant women), while others are less sensitive (resistant)
How are health guidance values developed?

- Review health effects information
- Identify most sensitive effects
- Determine relationship between amount of chemical and effect
- Determine amount that causes a specific effect
- Adjust amount for route, species, length of exposure
- Adjust amount for uncertainty (time differences, missing information, species)
- Adjust amount for differences in sensitivity between people

Health Guidance Value

**Hypothetical example**

1000 parts per billion (ppb) (rat)

100 ppb (human)

÷ 10 (no developmental study)

÷ 10 (asthmatic children)

1 ppb
Health Concerns: PM$_{2.5}$

- Can reach deep into the lung
- Short-term exposure: respiratory irritation, ↓ lung function, asthma attacks, irregular heartbeat, ↑ respiratory symptoms like coughing, wheezing, shortness of breath
- Short- and long-term exposure: premature death, cardiovascular mortality and hospitalizations, respiratory and asthma hospitalizations
- Sensitive populations
  - Elderly
  - Those with emphysema, asthma, chronic heart/lung disease
  - Infants/children (↑ childhood illnesses, ↓ lung function)
  - Pregnant women (↓ birth weight, preterm birth)

[Image of PM$_{2.5}$ particles and lung diagram]

https://www.masters.tw/wp-content/uploads/2015/07/pm2_52.jpg
Health Concerns: Diesel Exhaust

Noncancer
Respiratory irritation, cough, allergies, lung inflammation
↑ hospitalizations, ER visits, asthma attacks, premature deaths

Sensitive populations
- Those with respiratory and cardiovascular conditions
- Children
- Elderly

Cancer
Increased cancer risk
~70% of average Californian’s cancer risk from air pollution (CARB)
Health Guidance Values for Diesel Exhaust

Non-cancer
Chronic REL: 5.0 μg/m³
Effect: Changes in rat lung

Cancer
Unit risk: 0.0003 per μg/m³
Inhalation Cancer Potency Factor: 1.1 (mg/kg-day)^{-1}
Effect: Lung tumors in workers

Health Concerns: Wood Smoke

Contains thousands of chemicals, most concerning are:

- PM$_{10}$ and PM$_{2.5}$
- Carbon monoxide
- Irritants (nitrogen dioxide, sulfur oxides, aldehydes like acrolein and formaldehyde)
  - May play a role in smoke-triggered asthma attacks
- Carcinogens, including polyaromatic hydrocarbons (PAHs), benzene, 1,3-butadiene, formaldehyde

Contributes to indoor air pollution, particularly for PAHs

SJVAPCD program requiring reduction of residential wood burning associated with decreased hospitalization for cardiovascular disease (Yap & Garcia, 2015)

https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQr9ByO6xDAAtKVSQxeuMOKWnGKRPgcwA-yly5nCpBOUQAAAdz2w
Health Concerns: Metals

Lung cancer (arsenic, beryllium, cadmium, cobalt, hexavalent chromium, nickel)

Adrenal cancer (cobalt)

Kidney cancer (lead)

Nervous system (arsenic, lead, manganese, selenium)

Respiratory system (beryllium, cadmium, cobalt, hexavalent chromium, nickel)

Liver (selenium)

Kidney (cadmium)

Immune system (beryllium, nickel)

Reproduction and development (arsenic)

Blood (selenium)

Hair, skin, nails (selenium)

https://www.istockphoto.com/in/photo/human-organs-gm497303869-41750622
Health Concerns: Volatile Organic Compounds (VOCs)

Nasal tumors (formaldehyde, naphthalene)

Kidney cancer (ethylbenzene)

Leukemia (benzene)

Nervous system (benzene, hexane, styrene, toluene, xylenes)

Respiratory system (acrolein, formaldehyde, naphthalene, styrene, toluene, xylenes)

Liver (ethylbenzene)

Kidney (ethylbenzene)

Reproduction and development (benzene, ethylbenzene, toluene)

Blood (benzene)

https://www.istockphoto.com/in/photo/human-organs-gm497303869-41750622
How do we determine the risk from the amount of a chemical measured in air?

**Noncancer**

How does the amount in air compare to the Reference Exposure Level?

- Higher? May be some concern
- Reference Exposure Level
- Lower? Little concern

**Cancer**

How much does the amount in air increase cancer risk by?

- Higher? Concern
- Lower? Less concern
Reduced PM exposures linked with clear health improvements

• Utah Valley - Steel mill shutdown reduced PM and respiratory hospital admissions
• Dublin, Ireland - Coal sale ban reduced PM and death from heart and lung disease
• So. California - Children who moved to less polluted areas had improved lung function growth; those who moved to more polluted areas had decreased growth rates
• Review of cardiovascular mortality and PM in 51 U.S. metro areas shows PM reductions increased life expectancy
• Reduced diesel PM expected to decrease cancer risk

Number of days PM$_{2.5}$ was over the standard at Hamilton and Winery (Fresno) from 2000 to 2017
Questions?

Heather Bolstad, Ph.D.
heather.bolstad@oehha.ca.gov
(510) 622-3146