Development of Indoor Air Guidance for Benzene

Ian Mitchell (Meridian Environmental Inc.)
Ross Wilson (Wilson Scientific Inc.)
David Williams (Meridian Environmental Inc.)
Deborah Schoen (Health Canada)

MERIDIAN ENVIRONMENTAL INC

Health Canada Santé Canada

Outline

- Introduction
- Background Concentrations
- Toxicological Assessment
- Indoor Air Guidance Values
- Conclusions

Introduction

- Benzene is common contaminant of concern
- Inhalation is major exposure pathway
- Often a desire to measure indoor air concentrations
- But….background concentrations may exceed risk-based concentrations

Objectives

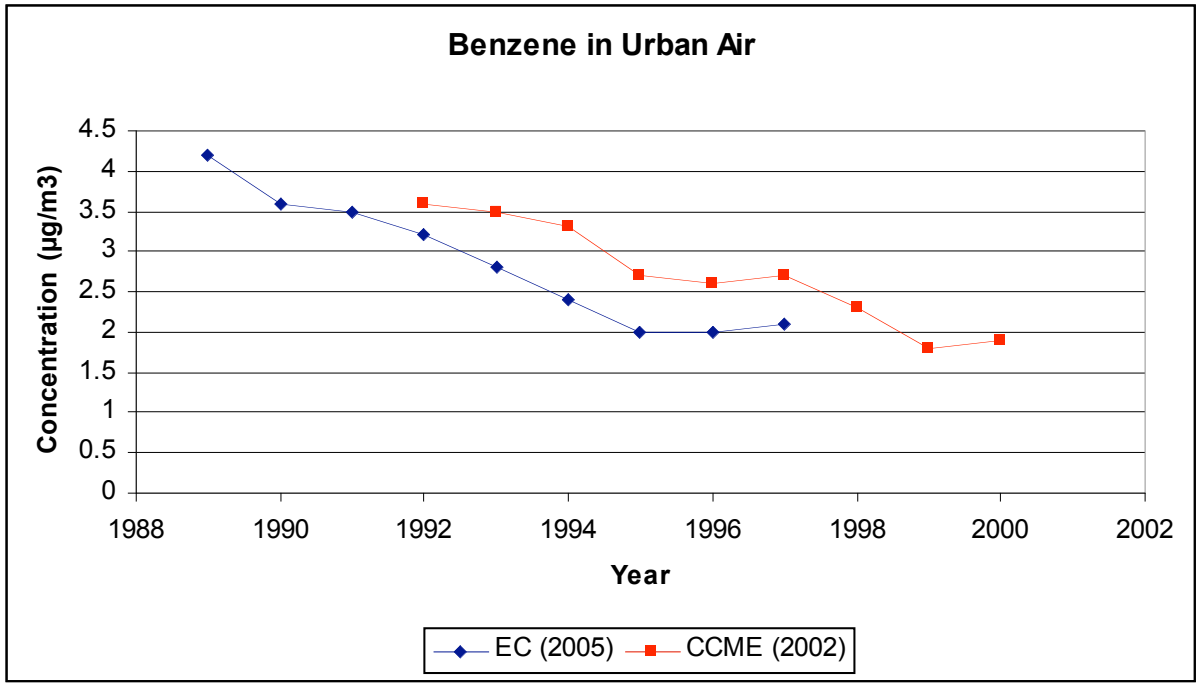
- To develop meaningful indoor air guidance values for benzene
- Consider background and toxicity
- Residential and commercial scenarios
- Policy decisions about acceptable risks

Background Exposure

- Exposure to benzene primarily from air (98%)
  - Also from consumer products, food/beverages (soft drinks)
- Various background sources in both ambient (outdoor) air and indoor air

Ambient Air

- Canada-wide data available
- General decreasing trend



MERIDIAN
ENVIRONMENTAL INC

Indoor Air

- Indoor concentrations generally higher than outdoor
- Sources:
  - Outdoor air
  - Household products
  - Smoking
  - Vehicles in attached garages
  - Hobby chemicals

Indoor Air Concentrations

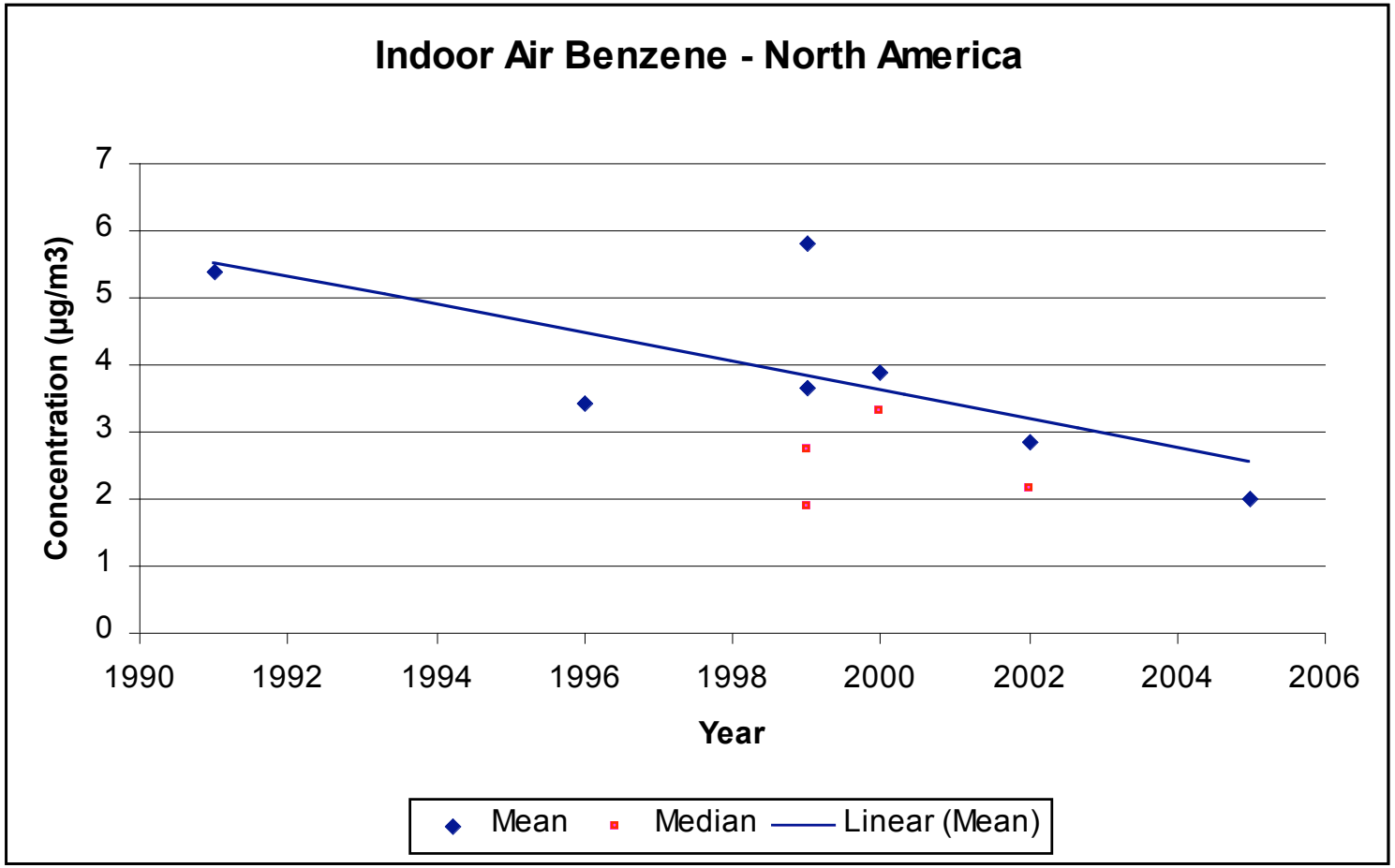
- Only 1 Canada-wide study identified
  - Davis & Otson, 1996
- Data from 1991-1992
- Mean: 5.4 µg/m^3
- Seasonal variations; concentration generally lowest when temperature is high
- But: evidence of decreasing concentrations since 1991-1992

Indoor Air Concentrations

Location	Year	Mean (µg/m^3)	Median (µg/m^3)	Reference
US	1975-1985		5.8	Phillips et al. 2002
US	1981-1987		7/10.5	Wallace 1989
Canada	1991-1992	5.4		Davis & Otson 1996
UK	1991-1992	8 (7.2/9.6)		Duarte-Davidson et al. 2001
Toronto	1996	3.42		Otson & Zhu 1997
Minnesota	1999	5.8	1.9	Sexton et al. 2004
New York	1999	3.64	2.75	Sax et al. 2006
UK	1999-2000	13.9		Kim et al. 2001
Los Angeles	2000	3.87	3.3	Sax et al. 2006
Ottawa	2002-2003	2.85	2.15	Zhu et al 2005
Michigan	2005	2		Batterman et al 2006

Numbers divided by '/' are for non-smokers/smokers

Indoor Air Concentrations



MERIDIAN
ENVIRONMENTAL INC

Indoor Air Concentrations

- Kindzierski (2007) found ratio of 95th percentile concentration to median concentration = ~4
  - Data from small Alberta towns
  - Median concentrations 0.9 – 5.3 µg/m^3
- Interpretation complicated by different sampling methods/durations
  - Many studies use passive sampling

Indoor Air Concentrations

- Kim et al. (2001): mean benzene conc. = 3.5 µg/m^3 before cleaning, 12.6 µg/m^3 after cleaning
- Concentrations affected by building ventilation
- Vehicle in attached garage may be main source of benzene
  - UK study indicated 80% increase

Indoor Air Concentrations

- Limited data for commercial settings
  - Excluding settings where benzene is used
- Concentrations generally similar to residential

Indoor Air Concentrations

- Based on available data, “typical” Canadian background concentration estimated to be ~3 µg/m^3
  - UK study (2001) suggested 5 µg/m^3 for rural, non-smoking, 7 µg/m^3 for urban, non-smoking, 10 µg/m^3 for smoking
- Considerable variation observed, however

Toxicity of Benzene

- Confirmed human carcinogen (Health Canada, 1996)
- Leukemia, lymphatic & hematopoietic cancer observed in epidemiological studies
- Some debate about mechanism, shape of dose-response curve

Toxicity Reference Values

- Health Canada TRVs → RSC of 3 µg/m^3 for 10^{-5} cancer risk, 0.3 µg/m^3 for 10^{-6} cancer risk
- Based on epidemiological studies (lymphatic and hematopoietic neoplasms)
- Generally consistent with other agencies

Derivation of Indoor Air Guidance Values

- Guidance value for indoor air derived using process similar to CCME guidelines

$$IAGV = \frac{RSC}{ET} + BAC$$

- ET = 1.0 for residential, 0.27 for occupational

Indoor Air Guidance Values

Land Use	10^{-5} risk	10^{-6} risk
Residential	6.0 µg/m^3	3.3 µg/m^3
Commercial or Industrial	14 µg/m^3	4.1 µg/m^3

Application

- Intended for indoor air samples – identify possible risks
- Highly variable background concentrations → background may exceed guidance value; important to identify sources
- May be used as trigger for further investigation
- Not for workplaces where benzene is used