Measurement of Exposures to Air Pollutants, Metals and Pesticides

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Measuring Exposures in a Community Health Study

- Typically, there is no single exposure method that can be used to accurately characterize an individual exposures in conducting a community health study
- Measurements methods, include :
  - environmental
  - personal
  - biologic samples
  - questionnaires
  - time activity diaries
  - Source-oriented classifications (e.g., GIS, proximity to roads/agricultural areas)
- Need to consider methods strengths and weaknesses:
  - method difficulties, burden, invasiveness, cost, measurement frequency, ability to archive, exposure period represented, etc.

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A White Paper on Measurement and Analysis of Exposures for the National Children's Study (NCS)

- A recent White Paper developed by an interdisciplinary team of scientists from EPA, CDC and academia summarizes and interprets environmental and personal exposure and biomonitoring sampling and analysis information for each critical life stage of a child.
- Potential exposure measurements, questionnaires and biological matrices which may be collected by the NCS are summarized in a series of tables by media, route and chemical class
- Can be obtained from: **http://nationalchildrensstudy.gov/research/methods_studies/final-white-paper-113004.cfm**

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Likely Agents of Interest

General Classes of Chemical Contaminants	Example Chemicals or Chemical Groups
Criteria Air Pollutants	PM2.5, PM10, ozone, NO2, SO2, CO
Environmental Tobacco Smoke	Criteria pollutants above and cotinine
Biological Agents	housedust mite, rodent, arthropod, pet, fungi, pollen, endotoxins, virus, food allergens, parasites
Induced Body Products	Hormones (Pregnancy/Adolescence), Histamine (Exercise & Injury), C-reactive Protein (Obesity)
Metals	mercury (total and methyl-), lead, manganese, tin
Organophosphorus Pesticides	chlorpyrifos, diazinon, malathion
Pyrethroid Pesticides	cis- and trans-permethrin, cypermethrin, cyfluthrin, allethrin, bifenthrin, deltamethrin, esfenvalerate, cyhalothrin
Phthalates	di-2-ethylhexyl phthalate, di-isononyl phthalate, diethyl phthalate, dibutyl phthalate, butyl benzyl phthalate
VOCs	aromatic hydrocarbons, acrylamide, aldehydes, aliphatic hydrocarbons, halogenated hydrocarbons
Persistent Organohalogens	PCBs, PCDFs, PBDEs, Dioxins
Organochlorine and Triazine Pesticides	DDE/DDT, chlordane, heptachlor, lindane, dieldrin, atrazine

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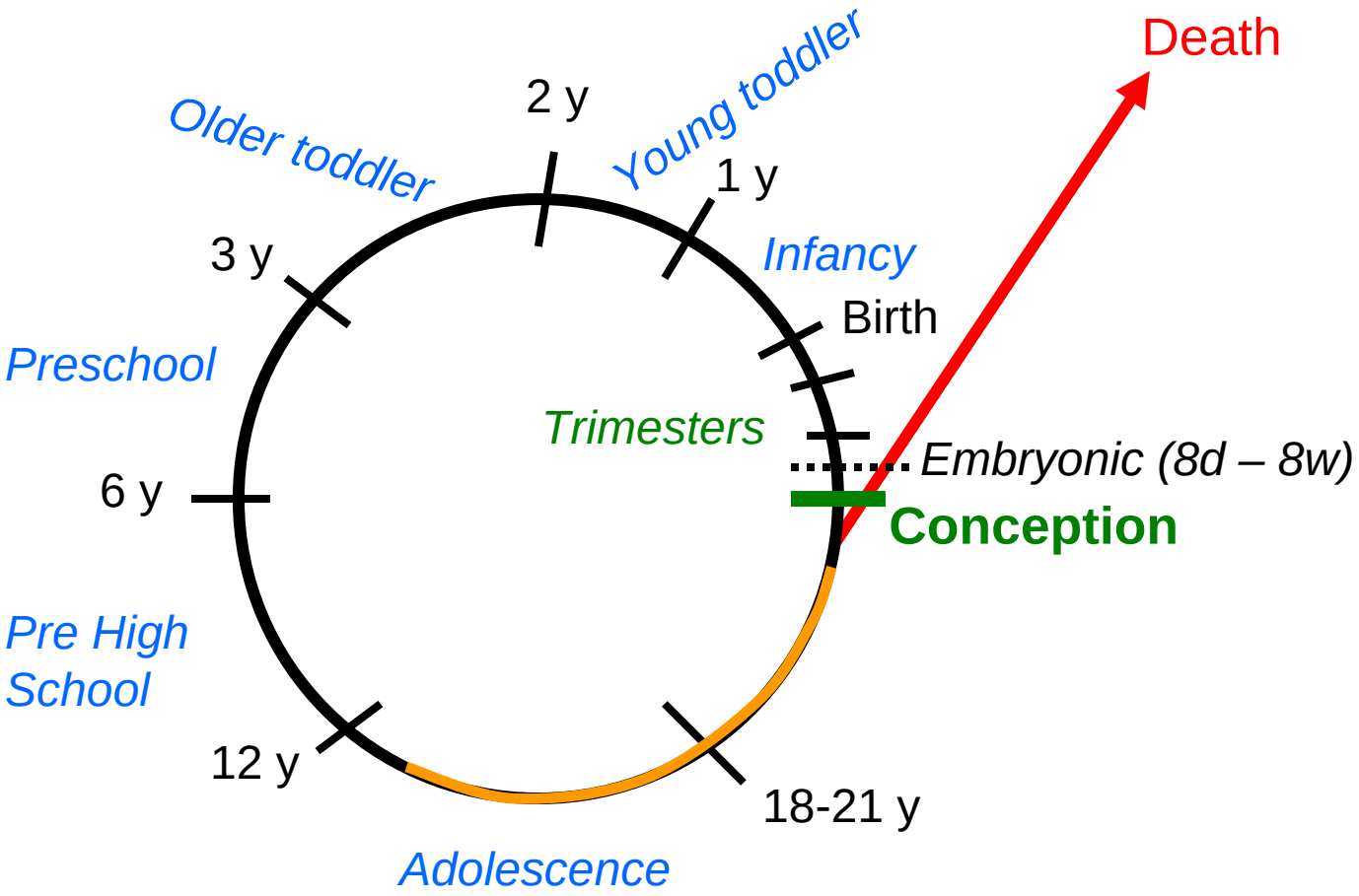
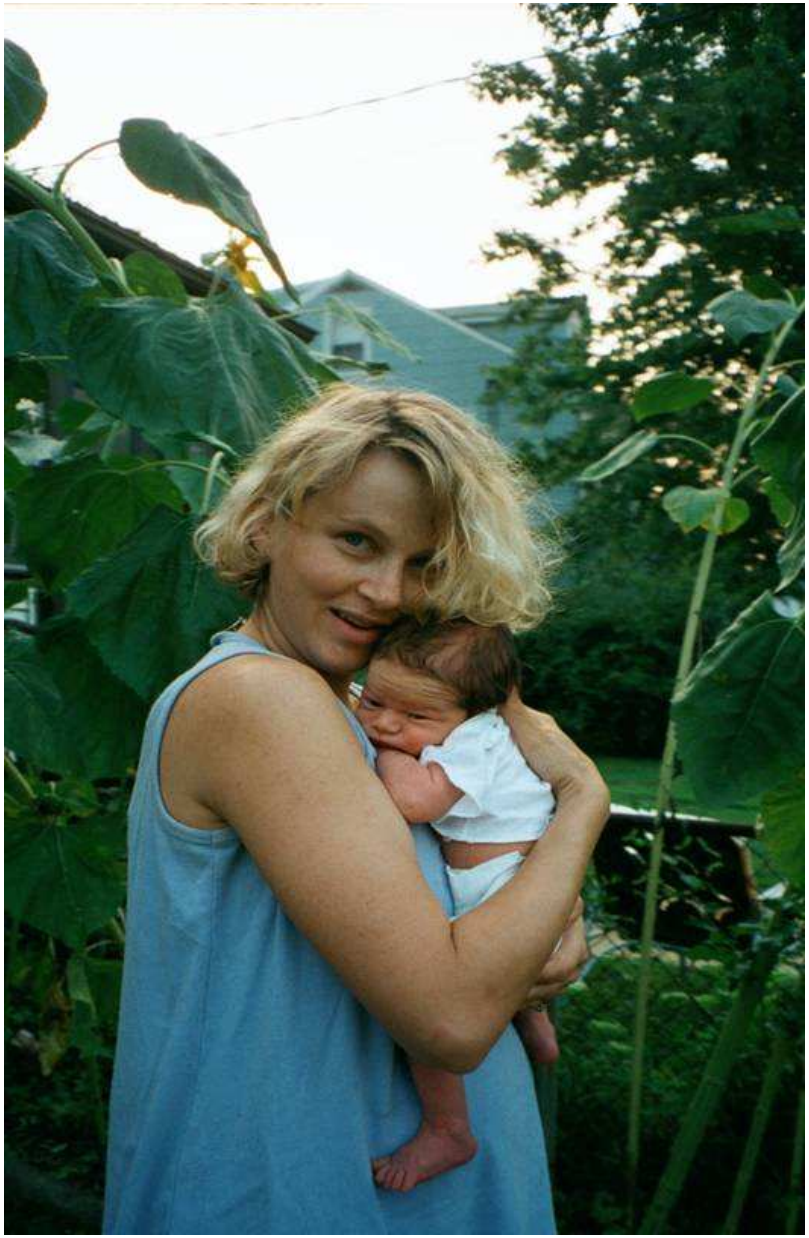
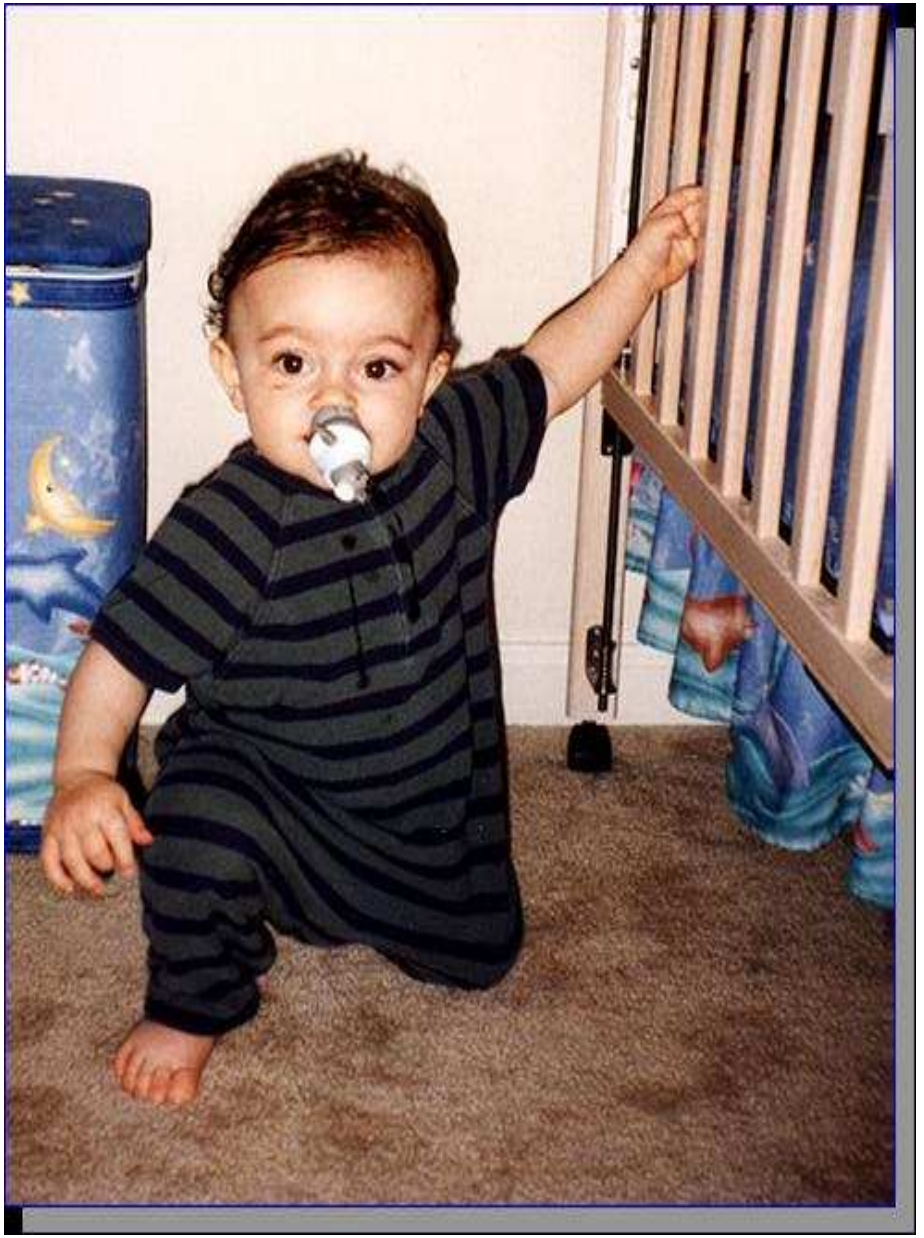
Life Stages Of Interest for Exposure Measurement



Source: Needham et al. (2005)





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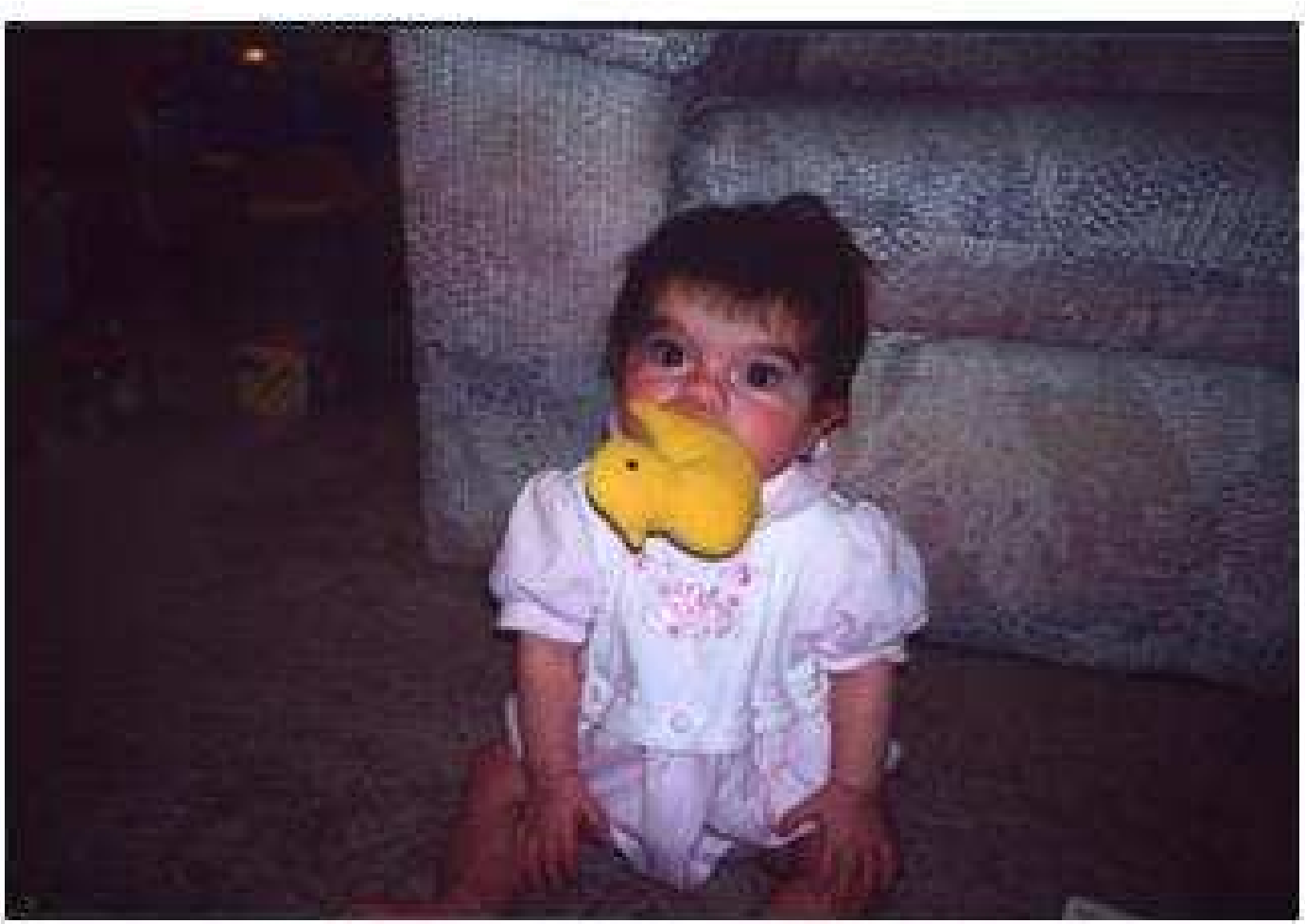
Object-to-Mouth Contact



Dermal Contact

Dietary and Non-Dietary Ingestion

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Ingestion and Dermal Contact

EPA

United States Environmental Protection Agency
National Environmental Supercomputing Center
Scientific Visualization Center

Sampling Methods*

$PM_{2.5}$: Real-time (Pers); portable Impactors (Ind/Out)
VOCs: OVM badges (Pers)
O_3, SO_2, NO_2: Badges (Pers)
Pesticides/PAHs: filter-XAD cartridge (Air); PUF roller (Floor/Carpets)
Dust: Vacuum
Dietary: Duplicate diet samples

Personal

$PM_{2.5}$/Metals
VOC's
NO_2
O_3
Hand Wipes

Indoor

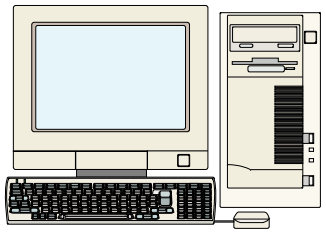
$PM_{2.5}$
VOC's
Gases
Pesticides
PAHs

Outdoor

$PM_{2.5}$
VOC's
Gases
Pesticides
PAHs

Neighborhood

$PM_{2.5}$, Gases (FRM)



Modeling

Indirect and Dietary Ingestion

1) Slide adapted from: Adgate (2004)

2) Use of product names do not constitute an endorsement

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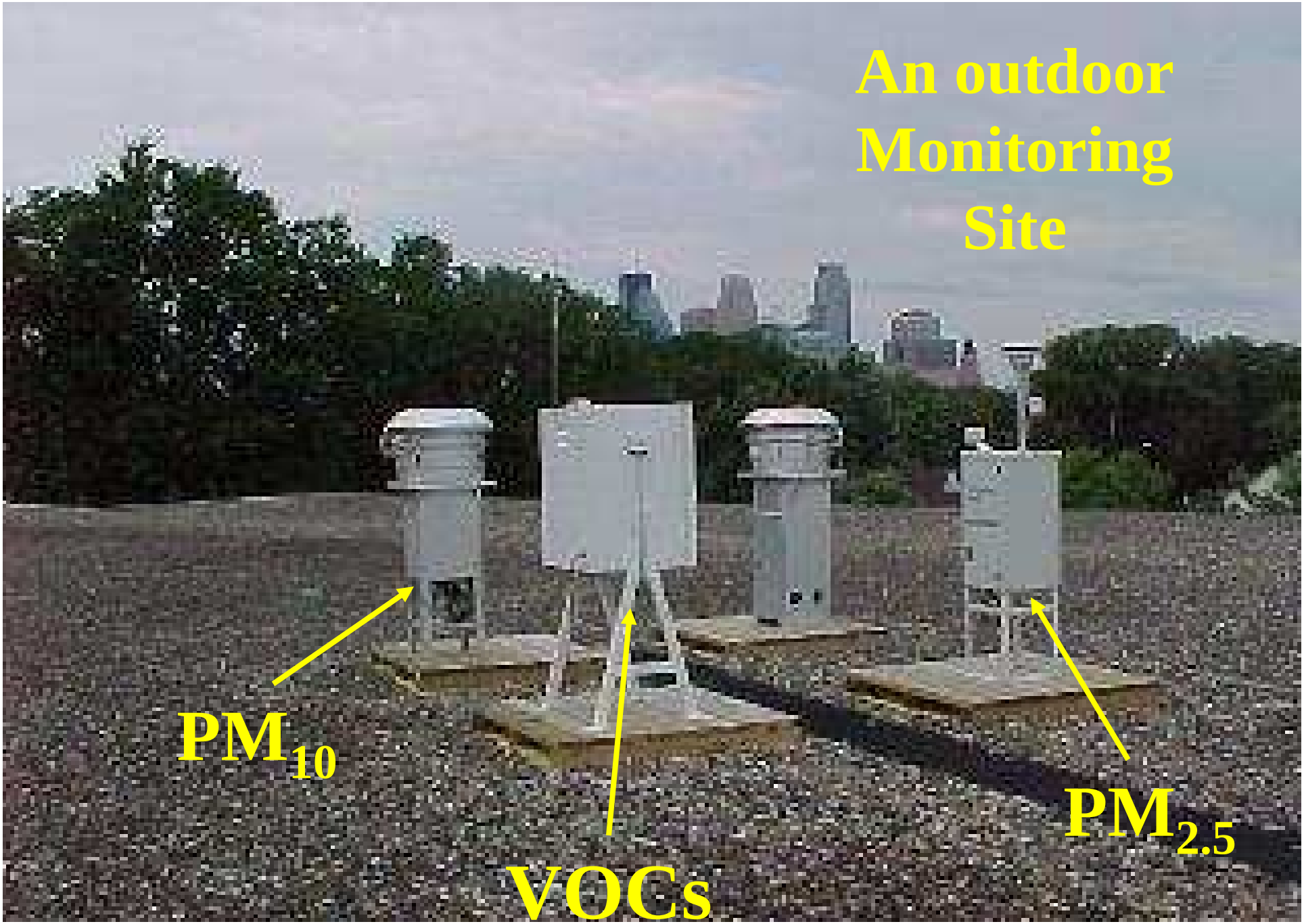
3M Personal Organic Vapor Monitor (OVM)*

**1) Source Adgate (2004)*

2) Use of product names do not constitute an endorsement



Source: Adgate (2004)

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Carpet Residue/Dust Sampling

EPA Baltimore PM Panel Study

Personal

Ambient

Outdoors

Indoors

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Personal Exposure Monitor (PEM) for Sampling $PM_{2.5}$

Examples of media and instruments for evaluation pesticide exposures

Biologic	Environmental	Instruments	Ecologic
Urine	Air (personal, indoor)	Questionnaires	Pesticide use
Cord blood	Dust	Time-activities	Land use
Blood	Soil	Macro activities	
Saliva	Water	Micro activities	
Breast milk	Surface residues		
Amniotic fluid	Clothing		
Meconium	Food		
Other	Other		

Personal monitoring

Questionnaires

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Criteria for Selecting an Exposure Method in a Community Health Study

- Assess importance of route/pathway by chemical type/class and life-stage
- Evaluate variability and uncertainty in implicit method for biomonitoring or personal or environmental measurements
- Determine suitability of method for testing key field study hypotheses
- Determine whether the method is appropriate for the entire study or on a subset

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Evaluation of When to Use Only Questionnaires

- Identify chemical(s) and associated media, routes, and pathways of exposure and biologic matrix to be measured for study hypothesis as main effect, potential effect modifier, or confounder
- Identify life stage(s) for which the exposure needs to be measured including any critical windows of susceptibility
- Determine whether exposure to the chemical at the critical life stage(s) can be reliably estimated through the use of questionnaire data or other indirect measures (e.g., ambient monitoring and historic use data, time-activity logs, etc.) alone

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Decision to Use Only Environmental Monitoring

- Biologic measure is not available, or
- Knowledge regarding the route of exposure is critical to testing the study hypothesis or for evaluating exposure mitigation options, and/or
- Exposures must by quantified during critical windows and this is more reliably done using environmental than biologic sampling, and
- Knowledge of target organ dose is not important, or toxicokinetic data is available for estimating target organ dose, and
- Exposures can be more reliably assessed or as reliably assessed using an environmental rather than a biological sample (especially when there is only one critical route of exposure), but the environmental sample is cheaper or participant burden lower.

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Decision to Use Environmental Monitoring: Examples

- Metals (e.g., manganese) by inhalation
- VOCs with passive diffusion badge
- Criteria pollutants or some organic compounds for which biomarker is either not available or specifically linked
- Exposures to non-persistent compounds (e.g., pesticides). Likely to require repeat multimedia measures design when exposures are intermittent

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Decision to Use Only Biologic Monitoring

- Knowledge regarding route of exposure is not critical for testing hypothesis, or biomarker reflects critical route of exposure, and
- Biomarker reflects exposure over critical life stage(s), or life stage is not important, and
- Biomarker reflects exposure to target tissue, or knowledge of target dose is not important, and
- Exposures can be more reliably assessed using a biomarker than by using an environmental sample, or
- Exposures can be as reliably assessed using a biomarker as by using an environmental sample, but assessment using the biomarker is cheaper, or the participant burden is lower.

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Decision to Use Biologic Monitoring: Examples

- Persistent organic pollutants or metals such as lead and mercury or other compounds that are persistent in both the environment and biologic samples
- Plasma or urinary cotinine (as dosimeters of cigarette smoke exposure) or other compounds that are non-persistent in biologic sample but for which environmental exposure is constant
- Chemicals that are non-persistent in biologic sample and environmental exposure is not constant and/or exposures vary across the populations or temporally but for which exposures can be reliably estimated using a biomarker and participant burden and/or cost is lower than for environmental sampling. Likely to require repeat measures design.
- Multimedia exposures that can be characterized at lower cost and participant burden using an internal dosimeter rather than multiple route environmental sampling.

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Decision to Use Both Environmental and Biologic Monitoring with Questionnaires

- Information regarding exposure route is critical, but exposures can't be reliably assessed with only environmental sampling, or
- Exposures must by quantified during critical windows and is more reliably done with environmental, and biologic sampling, or
- Biologic sampling is adequate to quantify internal dose, but environmental sampling is needed to characterize exposure route, or
- Environmental sampling is adequate to characterize exposure route, but biologic sampling is needed as internal dosimeter, or
- Exposures cannot reliably be assessed using either biologic or environmental sampling alone (e.g., pesticides or other non-persistent organic compounds may require intensive and repeat sampling depending on the scenario .

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Disclaimer

Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.









ISEA 2005
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at the Westin La Paloma Resort & Spa

Conference Deadlines

Abstract Submissions*	April 30, 2005
Early Conference Registration	July 15, 2005
Vendor and Sponsor Registration	Up to October 1, 2005
Notification of Paper Acceptance/Rejection	Early June
Late Breaking Posters	Accepted through September, 2005

*Visit www.conferencemanagement.net/isea for more information on submitting abstracts.

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Sampling for Exposure Assessment Studies
Roy Whitmore

& Mary Kay O'Rourke

All workshops are on a first come first serve basis. When the seats are filled, the workshop is closed. All fees due upon registration. ISEA reserves the option to cancel any workshop and fully refund the fees at the time of registration.

MINI-SYMPOSIA: Additional Symposia will be forthcoming on the ISEA conference website.

- **Air Pollution and Asthma** - Children's Centers Symposium (Chris Saint)
- **Children's Exposure to Toxics** - Children's Centers Symposium (Chris Saint)
- **Potential Exposures to Chemical or Biological Agents:** Risk Evaluation, Mitigation and Planning (Brett Singer & Richard Sextro)
- **Environmental Justice Issues** (Sarah Elwood)
- **Exposures Along the US-Mexico Border** (Shaibal Mukerjee, Rick Van Schoik & SCERP Investigators)
- **Exposure Assessment Needs for Environmental Policy, and Validity** (David MacIntosh)
- **Reliability of Bioaerosol Exposure Assessment Methods** (David MacIntosh)
- **Assessment of Environmental Exposures to Microbiological Agents** (John Scott Meschke & Kristina D. Mena)
- **Exposures to Arsenic** (Robin Harris & Séumas Rogan)
- **Breast Milk Monitoring for Environmental Contaminants:** A Useful Bio-fluid as a Measure of Maternal Body Burden and Infant Dose (Judith Schrieber)
- **Revisions to the Exposure Assessment Guidelines of 1992:** Proposed Changes and Panel Discussions (Gary Bangs)
- **Development of State and Regional Laboratory Capacity** (Larry Needham)
- **Understanding Dietary Exposure to Chemical Contaminants** (Lisa Melnyk)
- **The Detroit and Windsor PM and Air Toxics Research Studies -** Study Designs and Early Findings (Ron Williams & Amanda Wheeler)
- **Exposure Modeling for Outdoor and Indoor Air Pollution:** Methodology, Applications and Evaluation of Models (Ted Palma & Stephen Graham)

CONFERENCE SESSIONS

- Biological Aerosols
- Biomarkers & Exposure
- Bioterrorism & Other Disasters
- Children's Exposure
- Climate Change & Exposure
- Community Exposure
- Disparities in Exposure & Health
- Exposure Assessment (Aggregate & Cumulative)
- Exposures on Borders
- Exposure & Genetics
- Emerging Assessment Technologies
- GIS & Exposure
- Exposure Modeling
- Exposure & Health Surveillance
- Gene / Environment Interactions
- Pesticides
- Population Studies & Exposure
- Risk Assessment
- Scales of Exposure
- Selected Toxins
- Water
- Workplace Exposures
- Proposed sessions (watch website)

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