Role of Biomonitoring in Exposure and Community Human Health Studies

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Outline

I. Types of health studies and exposure assessment
II. Exposure assessment issues – chemical dependent
III. Interpreting biological monitoring data
IV. Example of community biomonitoring

I. Types of Health Studies and Exposure Assessment

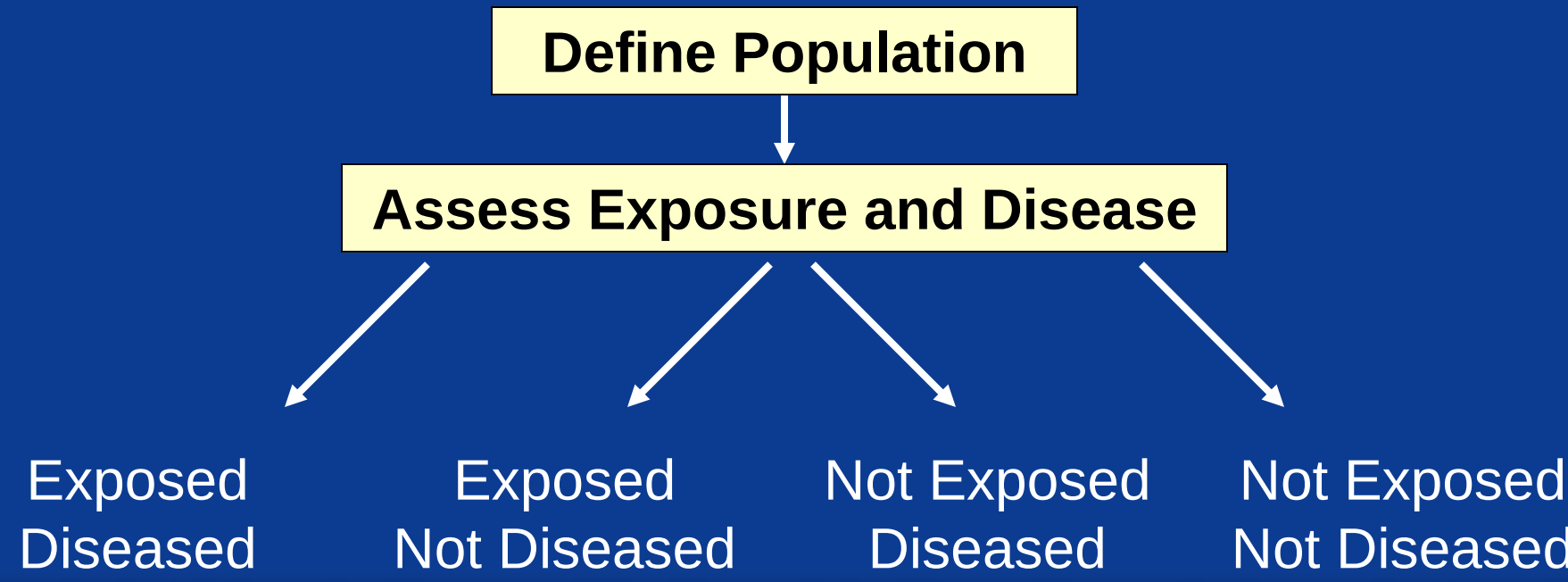
Purpose: Define any association between exposure and disease

Question: How best to assess exposure?

Types of Health Studies: Cohort (Longitudinal)

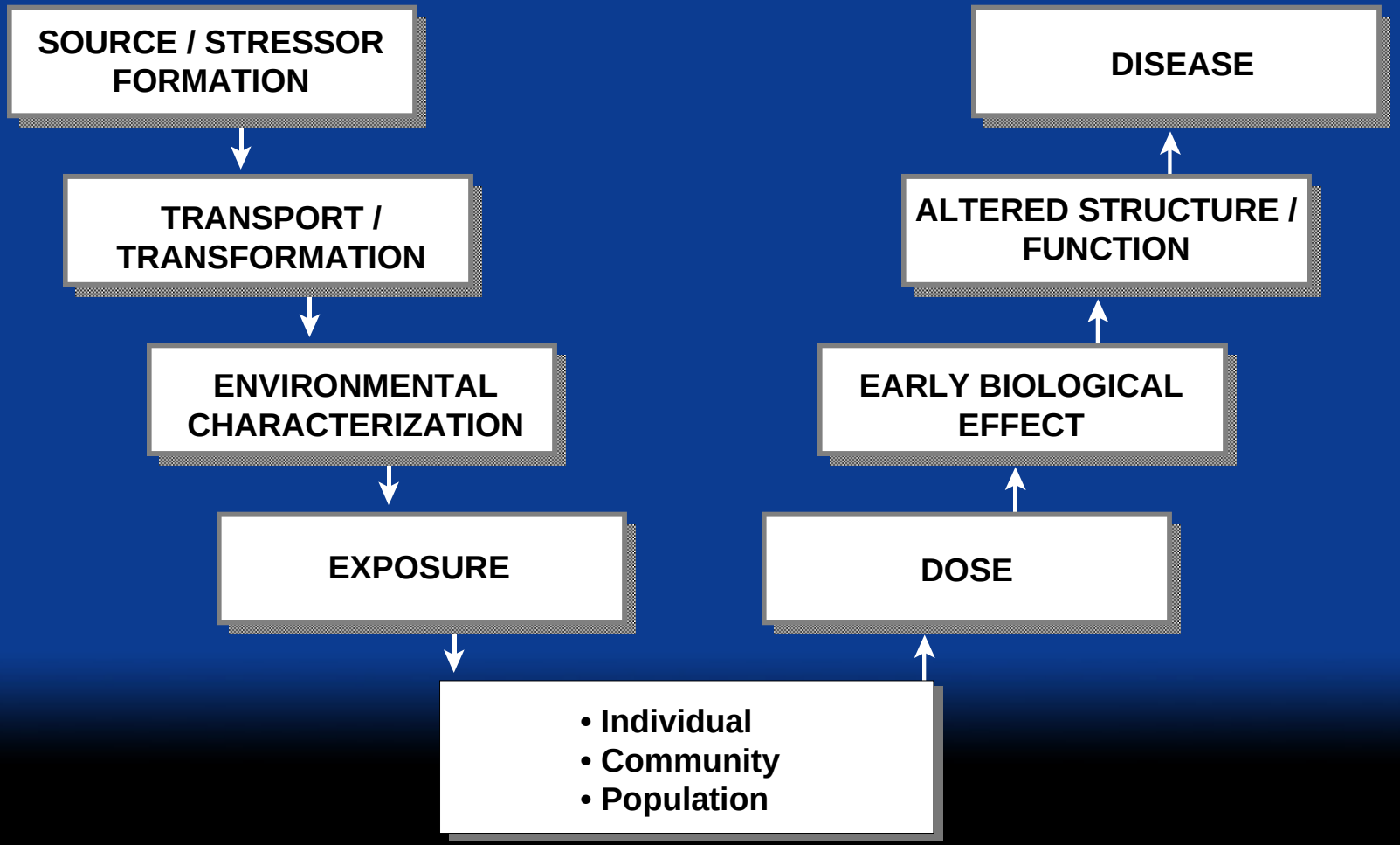
Types of Health Studies: Case/Control

Types of Health Studies: (Cross-Sectional)



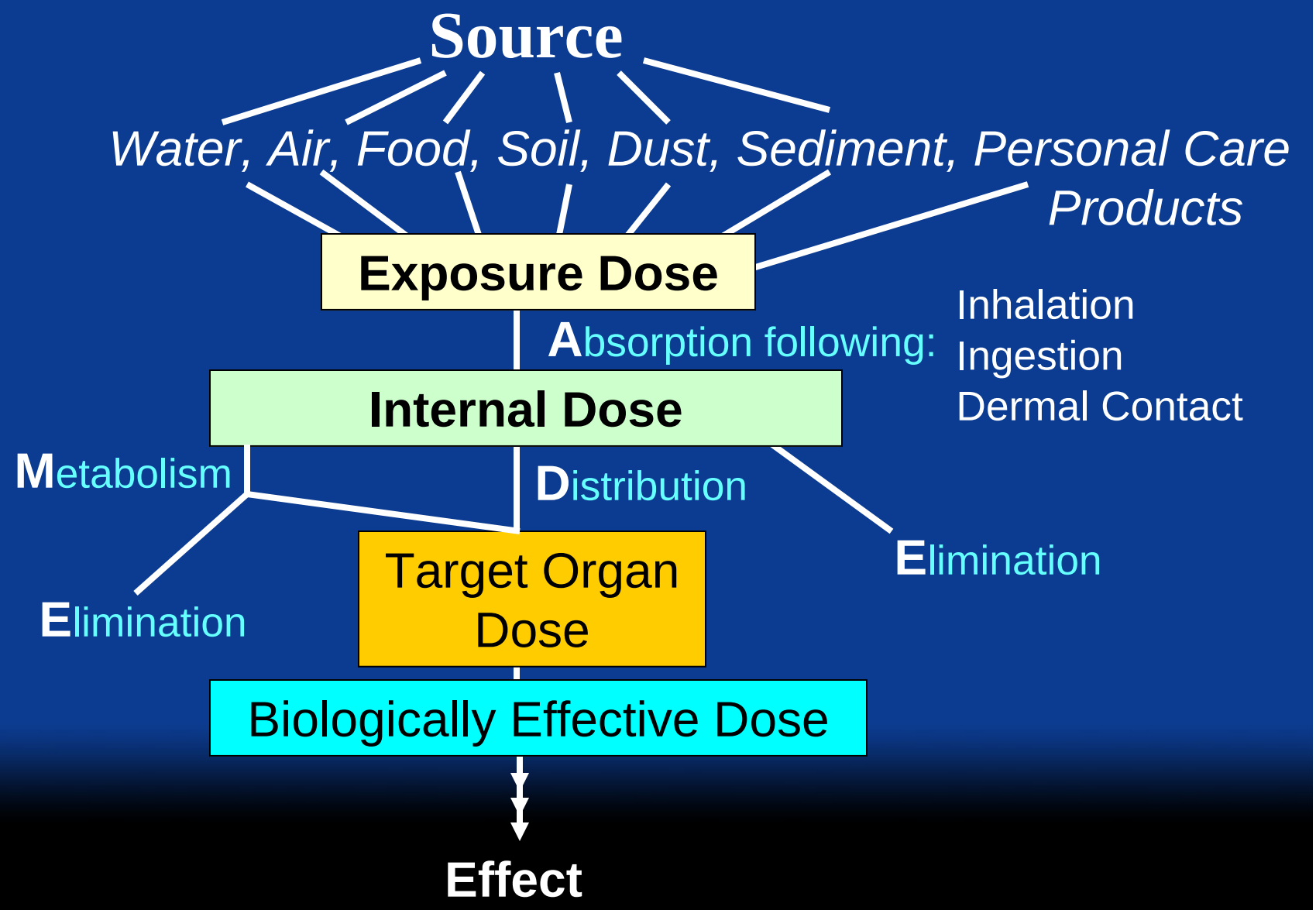
Environmental Public Health Continuum

For health studies: with certain caveats, the "closer" exposure is assessed to the effects, the more "accurate" is the relation between exposure and effects defined.



From: HESI Subcommittee on Biomonitoring, 2005

Exposure Pathway



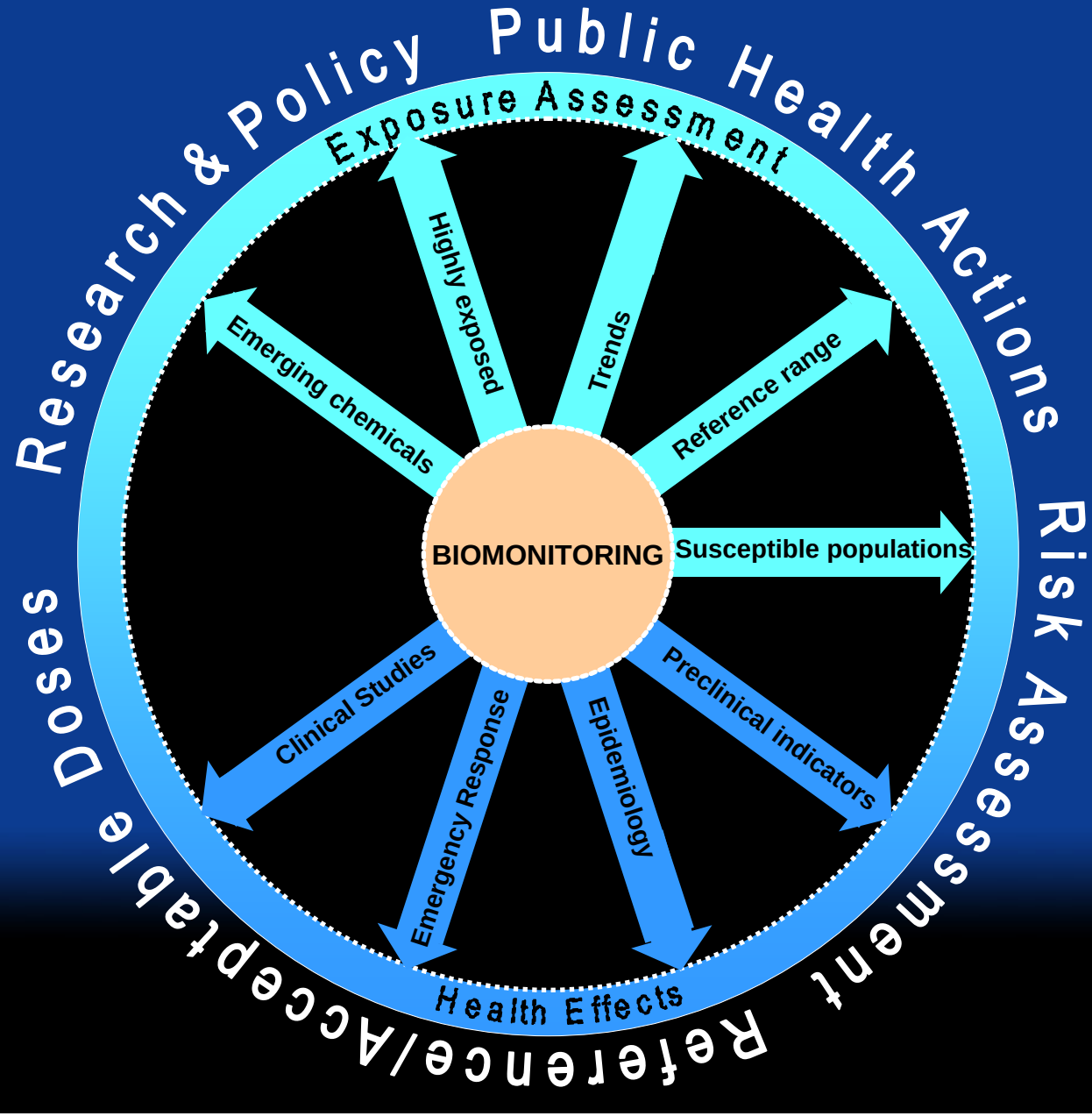
Needham, Barr, and Calafat. Neurotoxicology **26**:547-53(2005)

Predicting Adverse Health Outcomes Following Human Exposure to Environmental Chemicals is Problematic or "Why do people respond differently to similar exposures?"

*
- Genetic factors
- Demographic factors (age, sex, geography)
- Environmental and behavioral stressors
- Nutritional status
- Other exposures

Needham, Barr, and Calafat. Neurotoxicology **26**:547-53(2005)

Biomonitoring for Disease Prevention

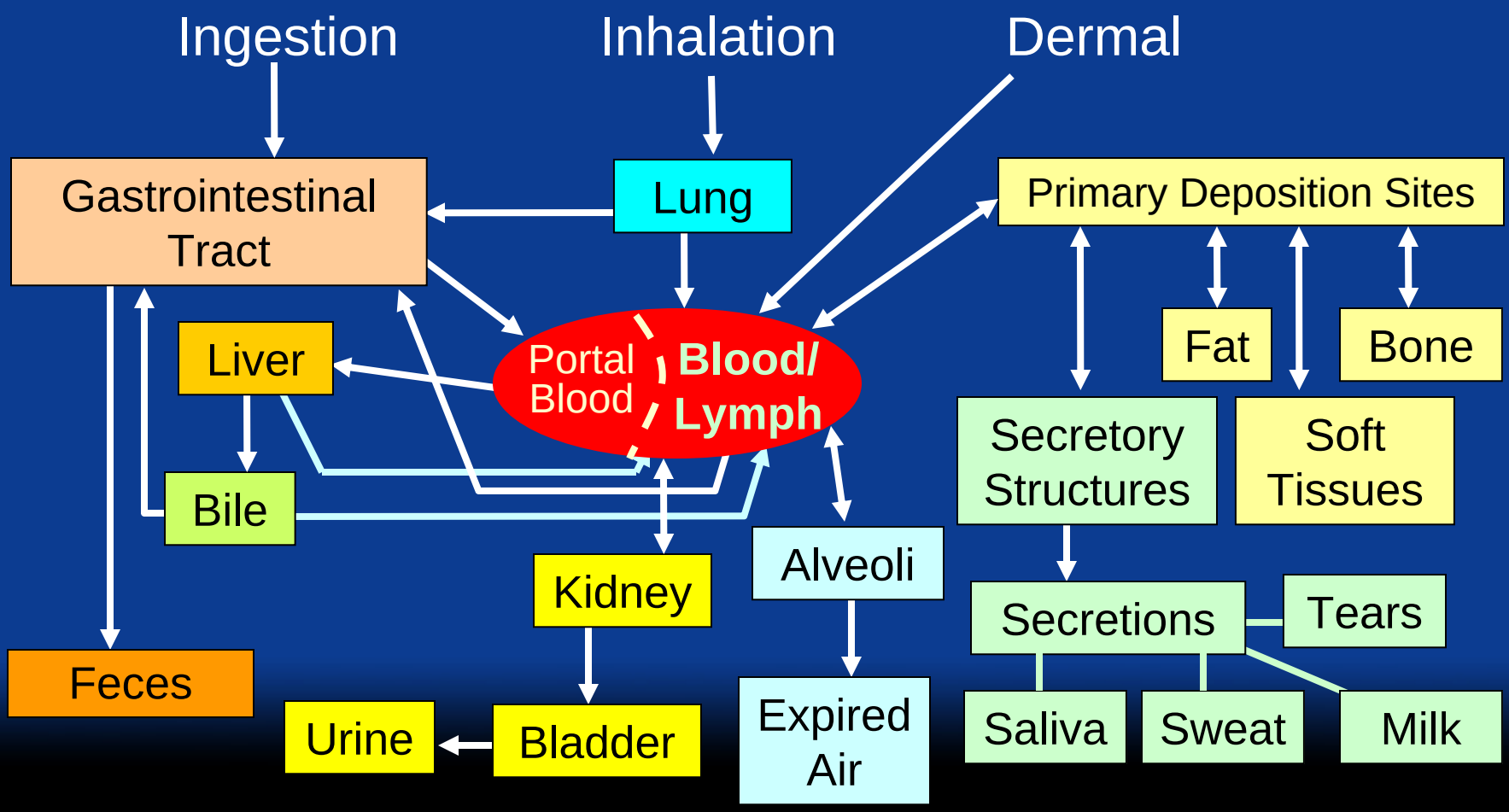


II. Exposure Assessment Issues Depending on the Chemical

Two Classes of Chemicals

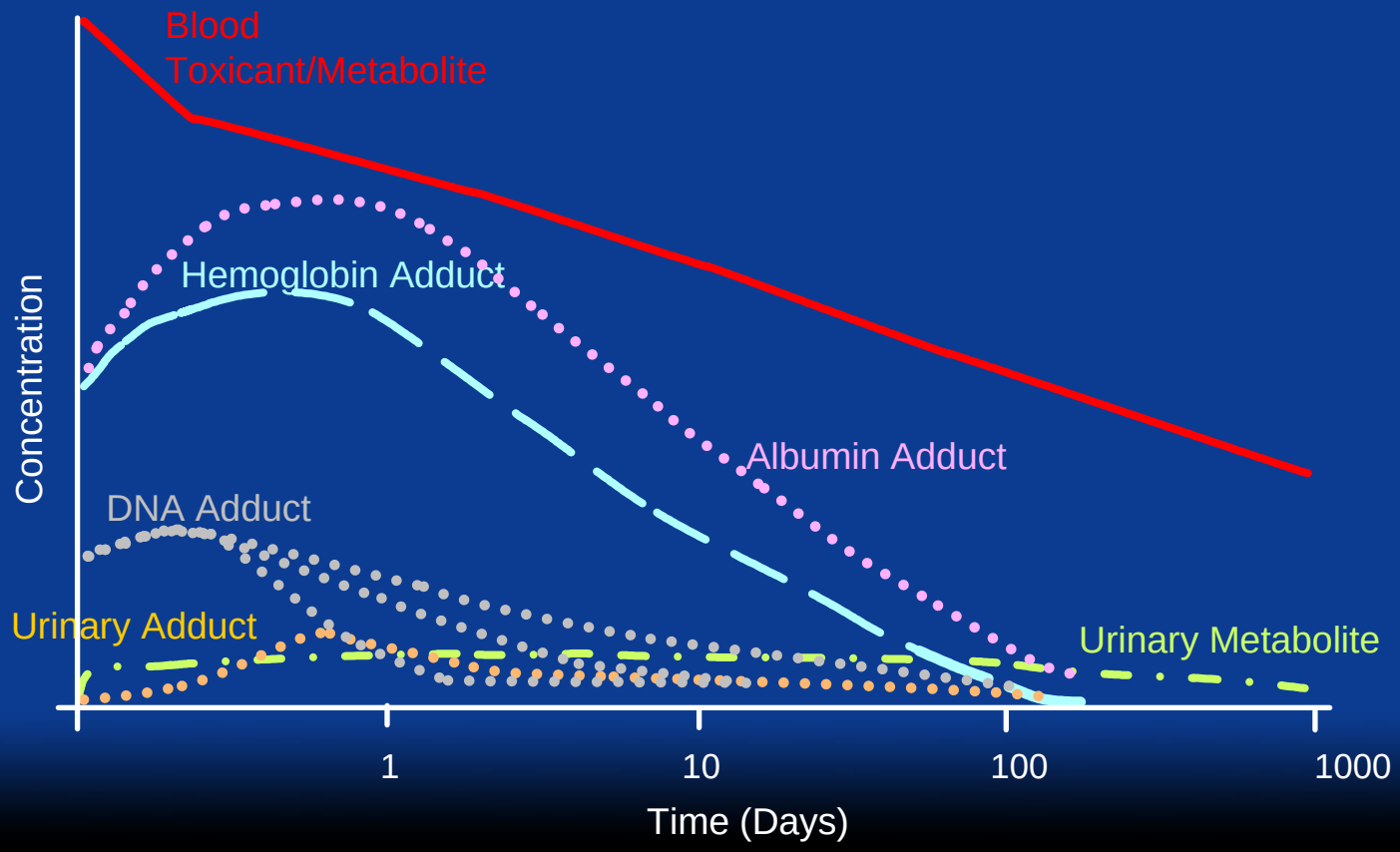
- Persistent in the Body (Long Half Lives)
- Nonpersistent in the Body (Short Half Lives)

Pharmacokinetics of Environmental Chemicals in Body and What Matrices Are Available for Analyses



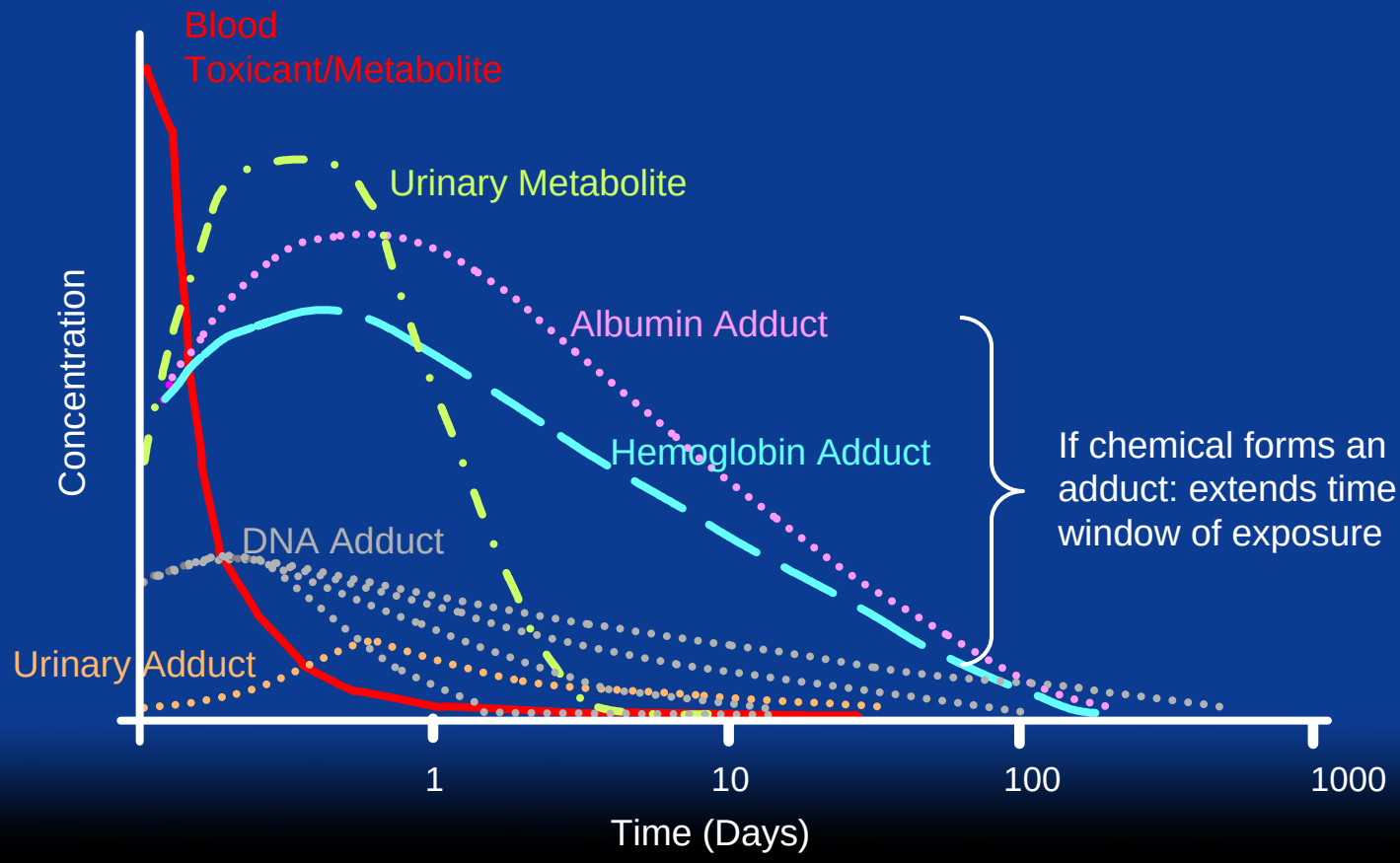
Needham, Barr, and Calafat. Neurotoxicology **26**:547-53(2005)

Post-Exposure Fate of a Persistent Chemical in Blood and Urine



Needham and Sexton, JEAEE **10**:611-629 (2000)

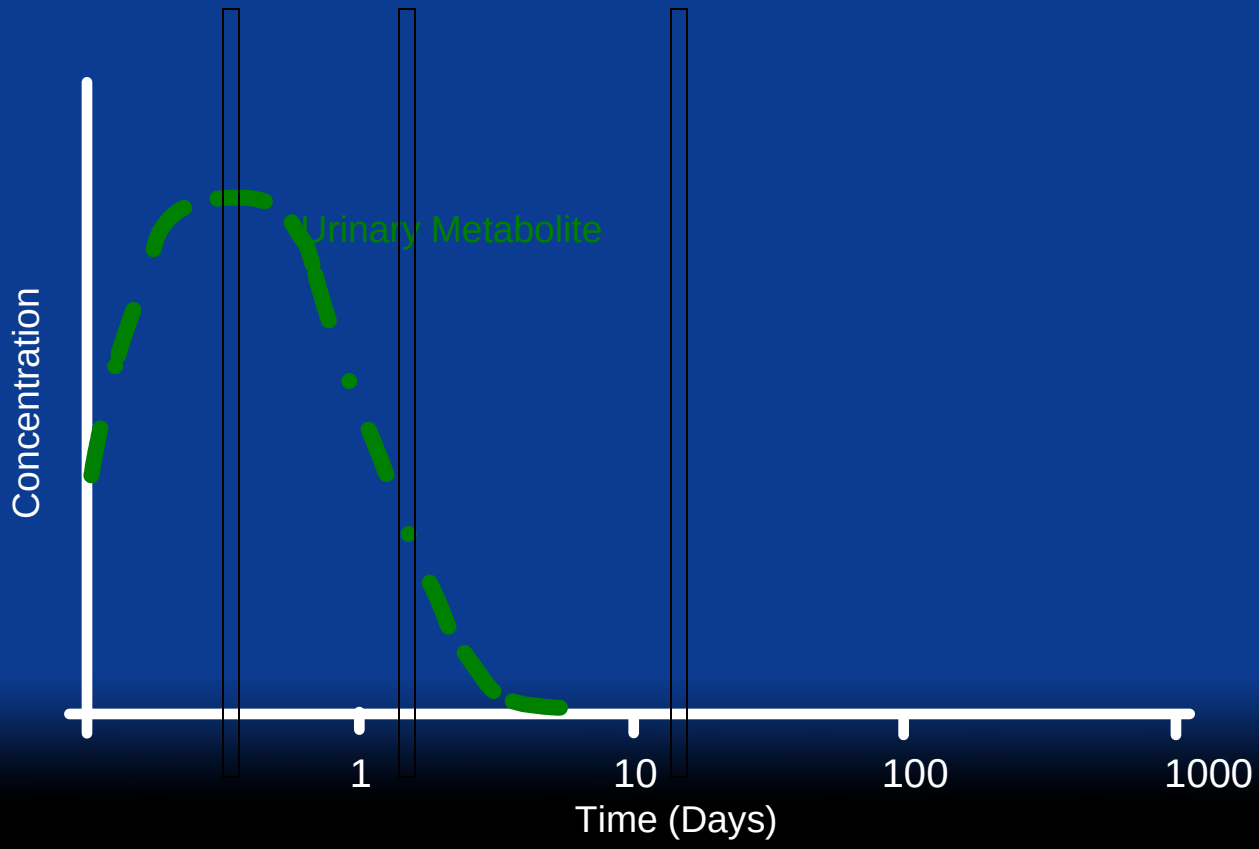
Post-Exposure Fate of a Nonpersistent Chemical in Blood and Urine



Needham and Sexton, JEAEE **10**:611-629 (2000)

Timing of Urine Collection May be Critical

Post-Exposure Fate of a Nonpersistent Chemical in Blood and Urine



CDC's Third *National Report on Human Exposure* – data from NHANES 2001-2002

Urine

Metals (13)

PAH metabolites

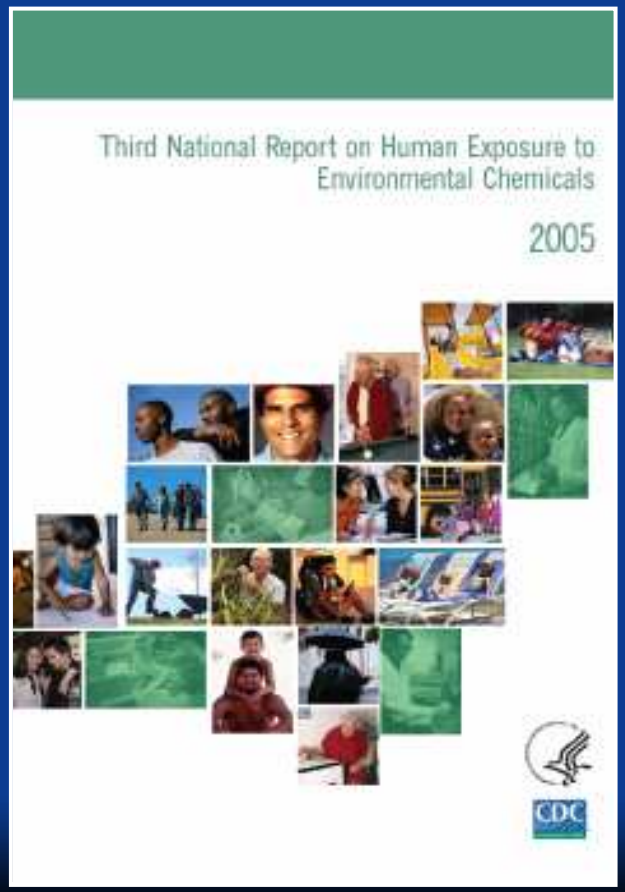
Phthalate metabolites

Pesticides

- Organophosphorus
- Carbamates
- Herbicides
- Pyrethroid

Repellants

Phytoestrogens



Released: July 2005

www.cdc.gov/exposurereport

Blood

Lead

Cadmium

Mercury

Serum

Dioxins

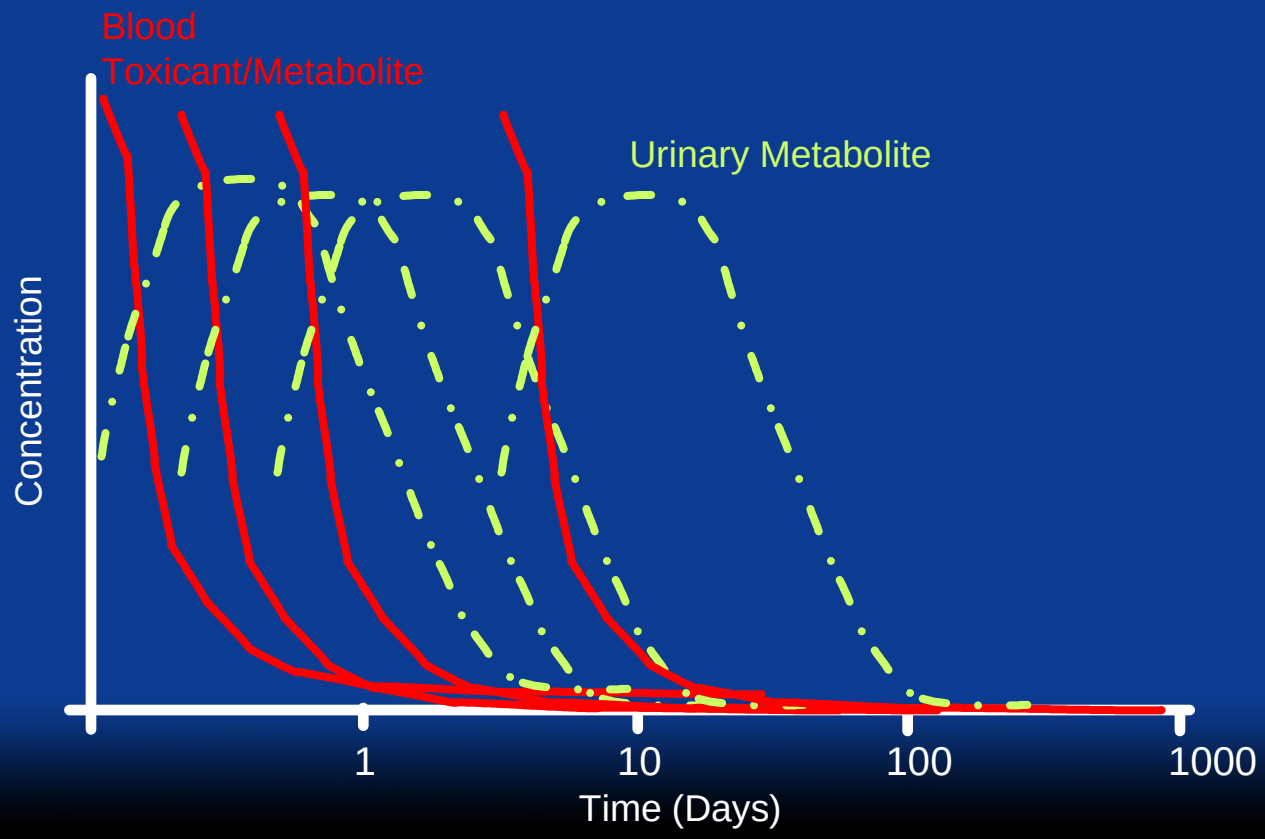
Furans

PCBs

Organochlorine pesticides

Cotinine

Post-Exposure Fate of a Nonpersistent Chemical in Blood and Urine



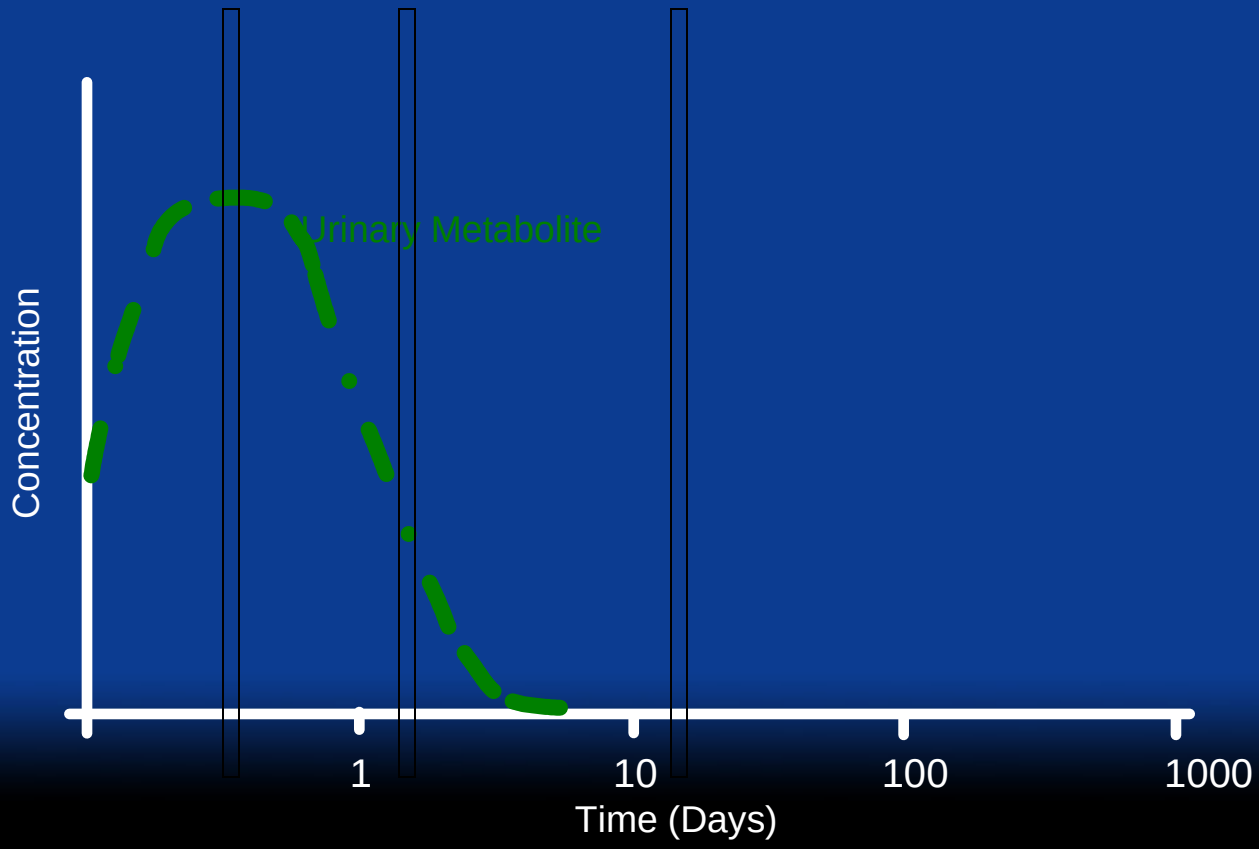
Barr et al., Environ Health Perspect **113:**1083-1091 (2005)

Needham, Barr, and Calafat. Neurotoxicology **26**:547-53(2005)

Nonpersistent Chemicals: Episodic Exposures

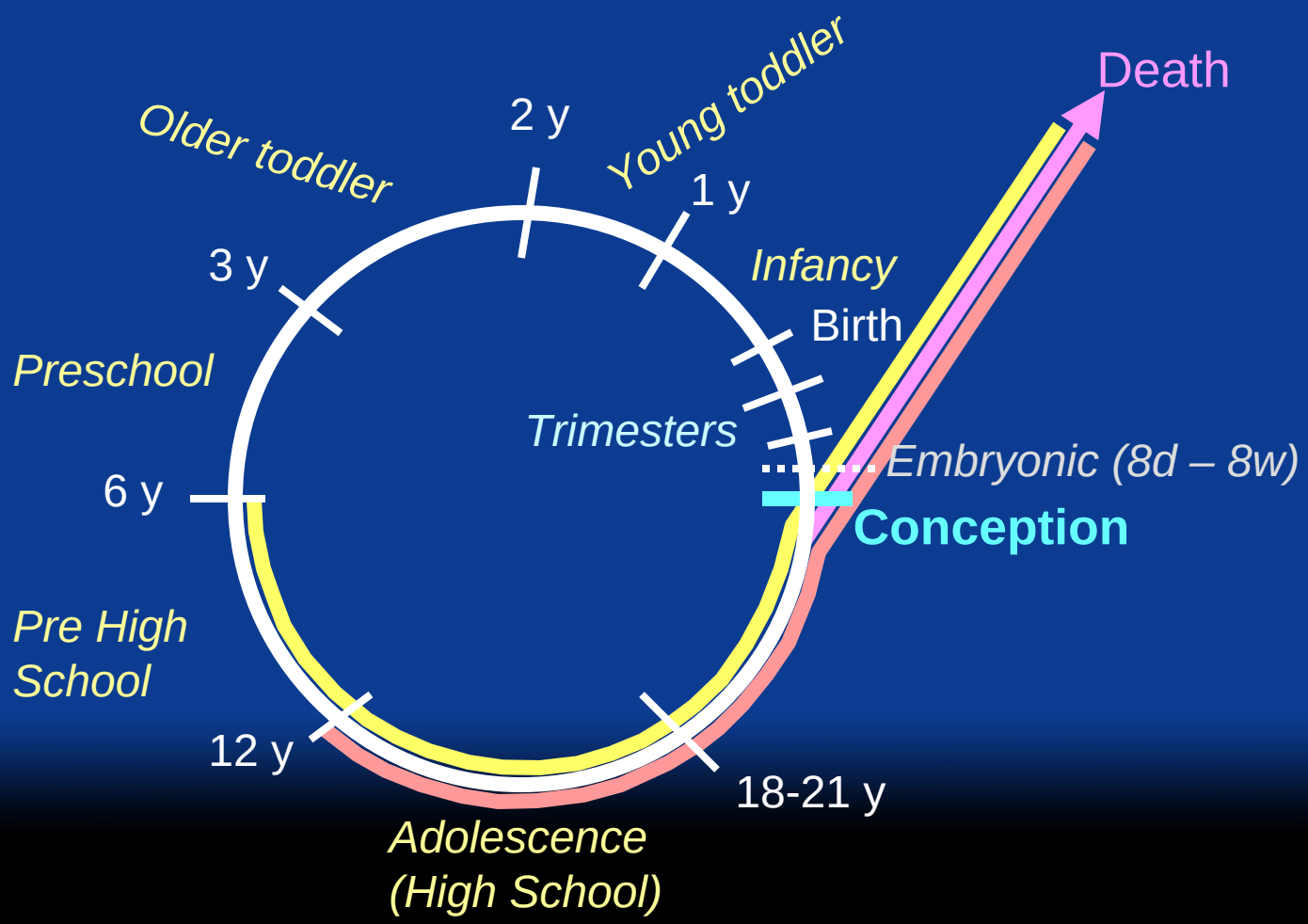
No “good” way to assess exposure!!

Post-Exposure Fate of a Nonpersistent Chemical in Blood and Urine



III. Interpreting Biological Monitoring Data

Life Stages of Children: Know Availability of Matrices



Needham, Barr, and Calafat. Neurotoxicology **26**:547-53(2005)

Relative Importance of Various Biological Matrices for Measuring Exposure During the Different Life Stages

Matrices	Adult preconception	Fetal			0-1 year	2-3 years	4-11 years
		1st	2nd	3rd			
Persistent Organic Chemicals							
Blood (whole)	1				1	1	1
Blood (serum)	1				1	1	1
Blood (plasma)	1				1	1	1
Urine	3				3	3	3
Saliva	3				NA	3	3
Hair	3				3	3	3
Nails	3				3	3	3
Adipose Tissue	1				NA	NA	NA
Feces	3				3	3	3
Semen	3				NA	NA	NA
Breath	3				NA	3	3
Teeth	NA				NA	NA	3
Cord Blood	1	1	1	1	3	3	3
Meconium	3	2	2	2	3	3	3
Milk (maternal)	1	1	1	1	1	3	3
Blood (maternal)	1	1	1	1	1	3	3
Urine (maternal)	3	3	3	3	3	3	3
Hair (maternal)	3	3	3	3	3	3	3

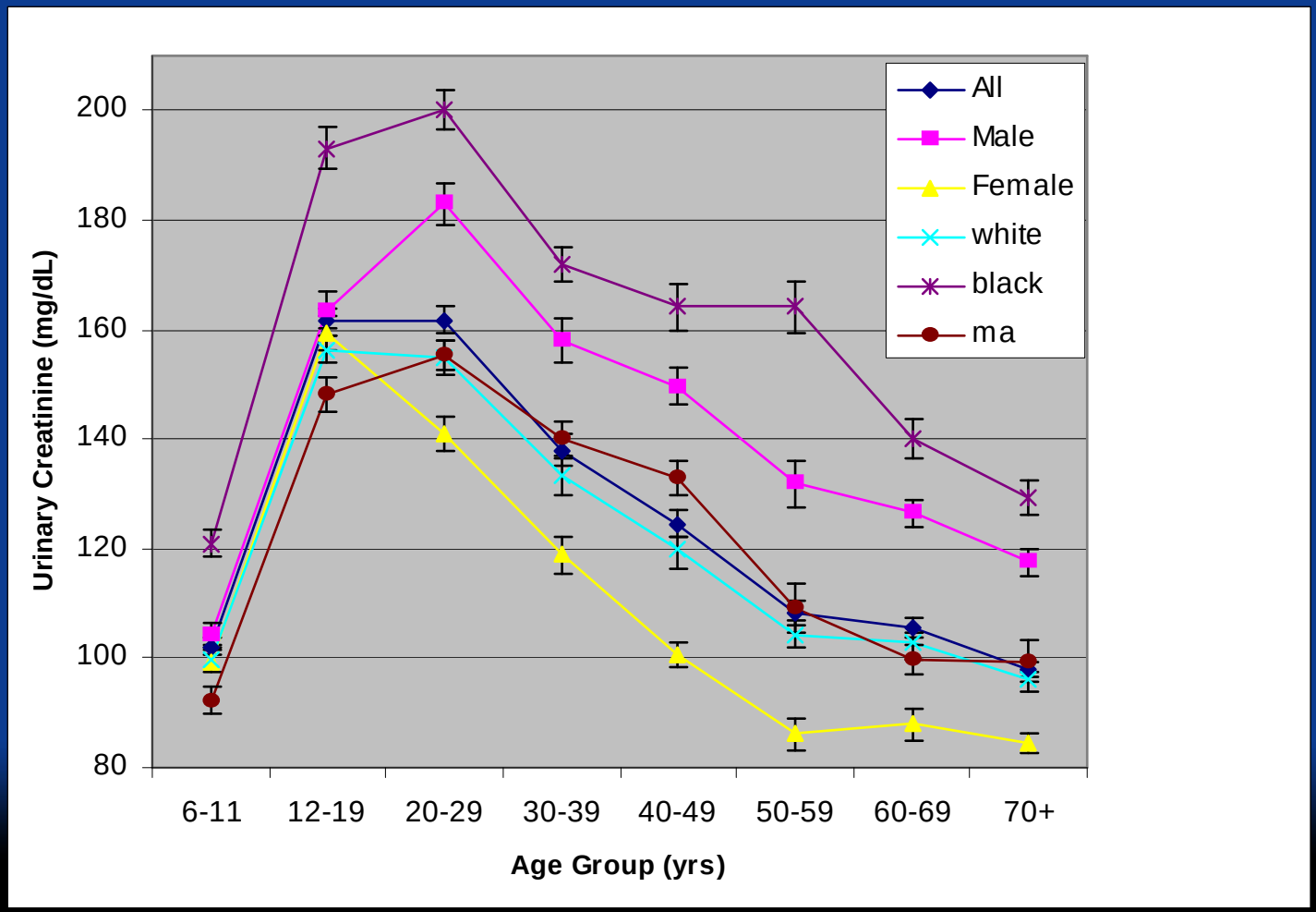
Barr, Wang, and Needham. EHP **113**:1083-91(2005)

Creatinine in Urine:

To Adjust or Not Adjust

Creatinine Variability Among Populations

Comparison of Urinary Data Based on Age, Race, and Sex



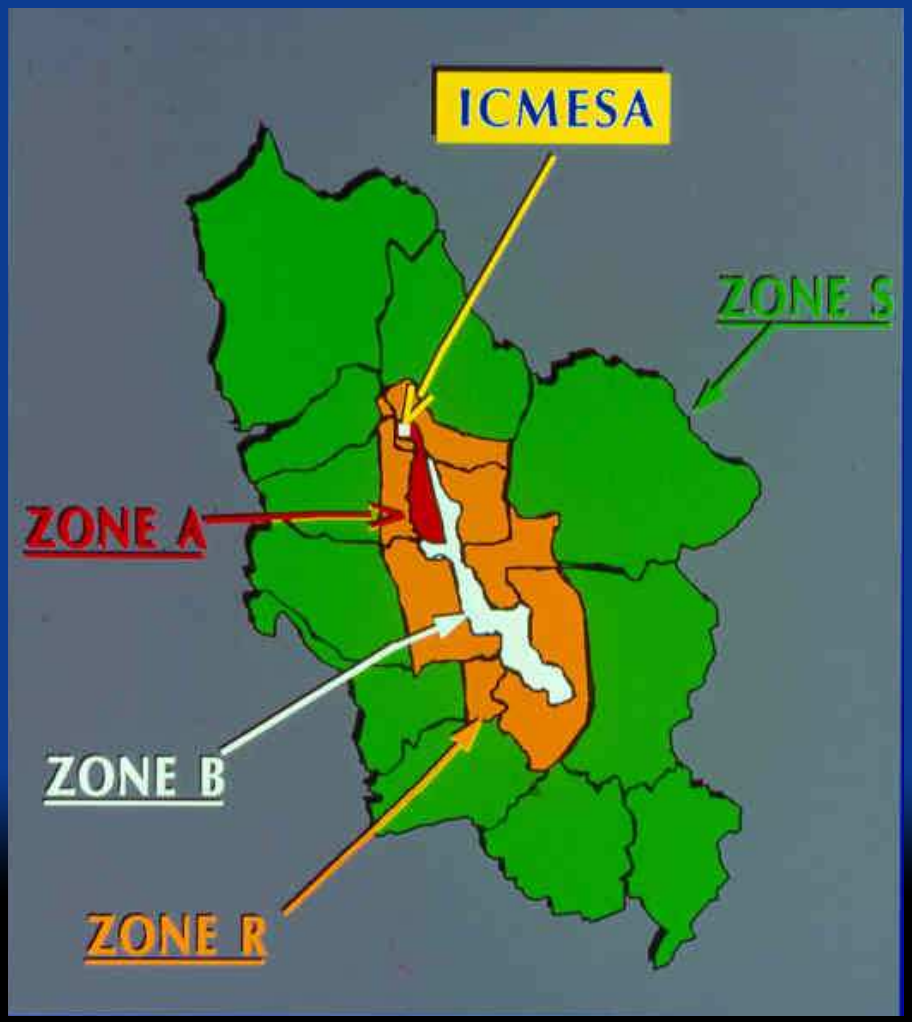
Barr et al., Environ Health Perspect **113:**192-200 (2005)

IV. Community Monitoring Example

Seveso, Italy Scenario

- Saturday – July 10, 1976
  - Explosion in a TCP reactor
  - Atmospheric release of kilogram amount of 2,3,7,8-TCDD
- People potentially exposed
  - A Zone –736
  - B Zone – 4,737
  - R Zone – 31,800
- Highest measured level
  - 56,000 ppt (Oct. 1976)

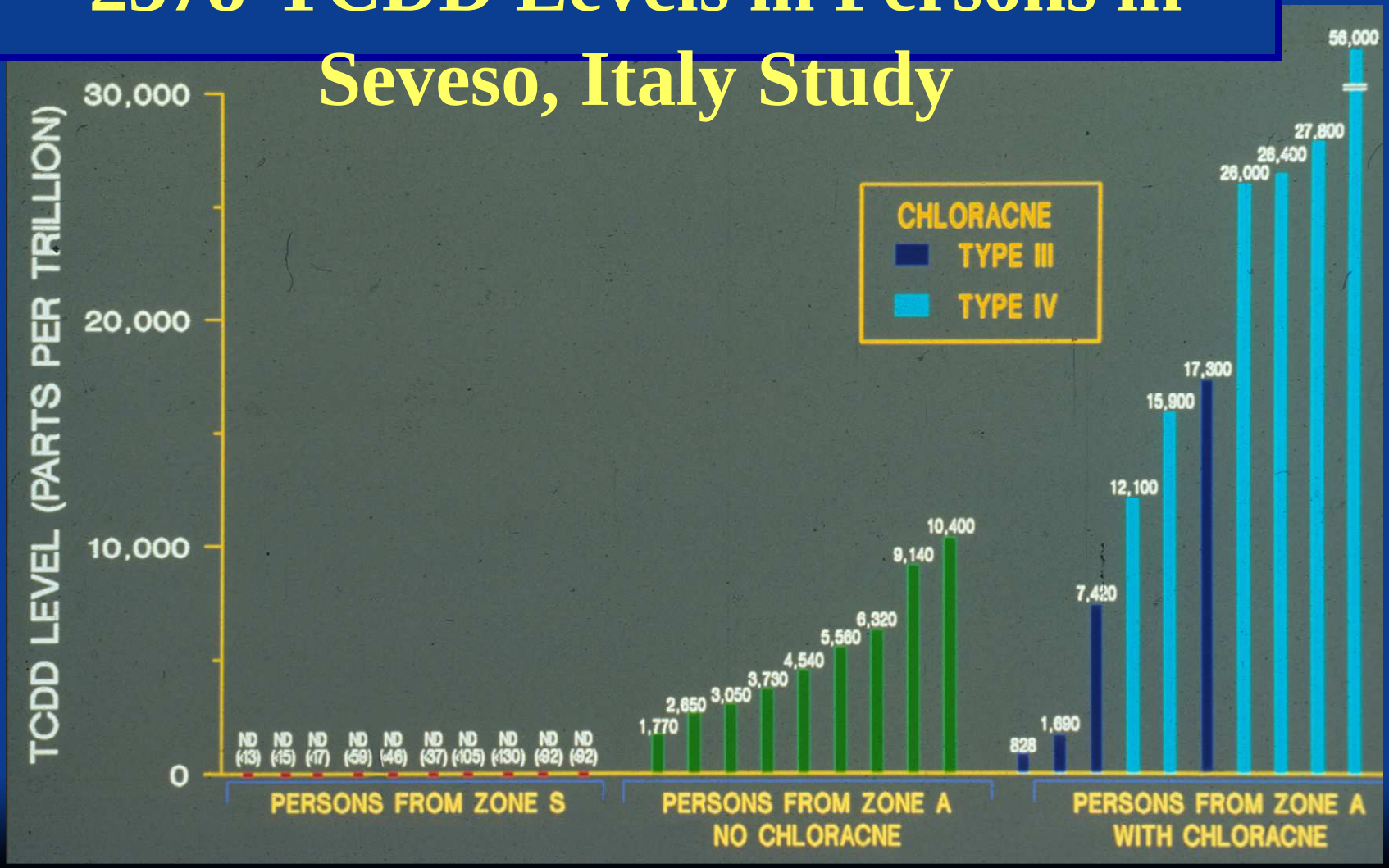
Map of Seveso Showing Contaminated Area



Seveso, Italy

- Acute exposure
- Wide range of exposure
- Both genders
- Adults and children
- Serum specimens saved from 1976-1985 medical exams

2378-TCDD Levels in Persons in Seveso, Italy Study



Mocarelli et al. *J Toxicol Environ Health* **32** (1991) 357-366.

Change in Sex Ratio with Exposure to Dioxin

- Seveso, Italy Dioxin Explosion
  - July 10, 1976 factory explosion
  - A Zone (736 people)
- Normal sex ratio (106 M and 100 F)

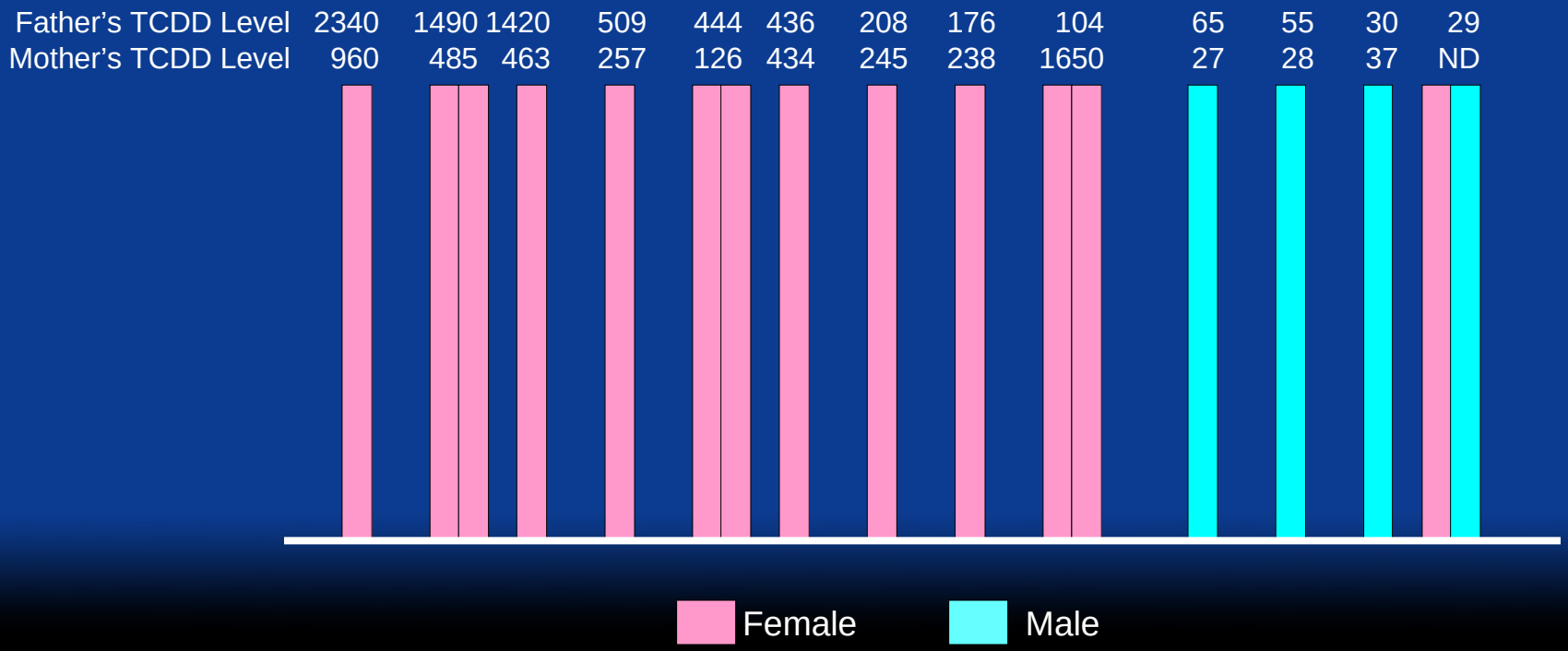
Mocarelli, Brambilla, Gerthoux, Patterson, Needham, *The Lancet*, **348**:409 (1996)

Change in Sex Ratio with Exposure to Dioxin

- 74 Total births from 9 months after accident to December 1984 (~1 half-life of serum TCDD)
  - Excess of females (26 M vs. 48 F)
  - X^2 ($P < 0.001$)
- From 1985 to 1994
  - 60 Males and 64 Females

Mocarelli, Brambilla, Gerthoux, Patterson, Needham, *The Lancet*, **348**:409 (1996)

Sex Distribution of Children Born April 1977 – December 1984 to Parents with Measured Serum TCDD Levels (ppt) in Zone A – Seveso, Italy



Needham et al. Teratogenesis, Carcinogenesis, and Mutagenesis. **17**:225-240 (1997).

Paternal Concentrations of Dioxin and Sex Ratio Offspring

In Seveso Area:

- From 1977-1996: 346 girls, 328 boys born
- Measured 1971, 1977 TCDD levels in 239 men, 296 women
- No association with lowered sex ratio with maternal TCDD levels
- Lower sex ratio with increasing paternal serum TCDD levels (p=0.008)
- Fathers exposed when <19 years sired significantly more girls (sex ratio = 0.38; 95% CI = 0.30 – 0.47)

Mocarelli, et al. *The Lancet*, **355**:1858-1863 (2000)