

Problem Formulation



- Planning, scoping, and establish goals
 - Estimate dose for risk assessment
 - Support regulations for specific chemical sources
 - Evaluate remedial alternatives
- Identify sources, media, pathways, and scenarios

Exposure Assessment Framework



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Development of Conceptual Model

- Consider important life stages
- Windows of potentially high exposures due to age-specific behaviors and physiology
- Identify sources
- Identify pathways
- Develop exposure scenarios

Iteration between the exposure and hazard assessments is critical



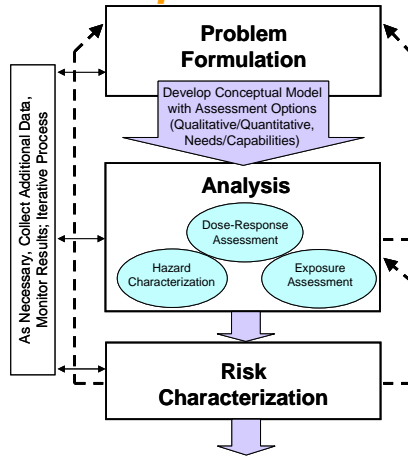
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Children's Risk Assessment Conceptual Framework



Adapted from Olin and Sonawane (2003)

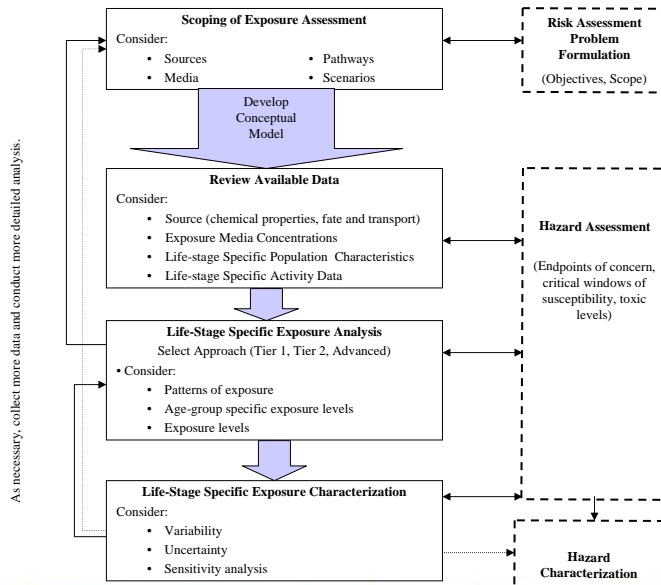
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Flow Diagram for Exposure Assessment for Children



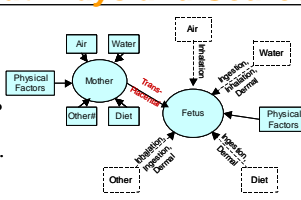
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Identifying Pathways and Sources

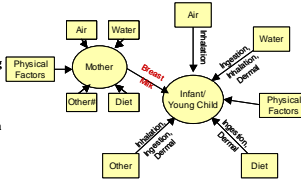
Prenatal:

All exposures to the fetus occur transplacentally or via physical factors. The mother's exposure to environmental media can be a significant source of exposure to environmental media for the fetus.



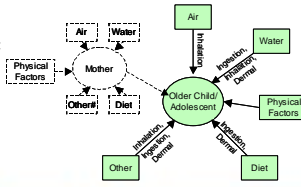
Infant/Young Child:

Exposures to the infant and young child can occur through all environmental media. When breastfed, the mother's exposure to environmental media can be an additional source of exposure to the infant.



Older Child/Adolescent:

Exposures to the child and adolescent can occur through all environmental media. The mother's exposure is no longer a factor for the child.

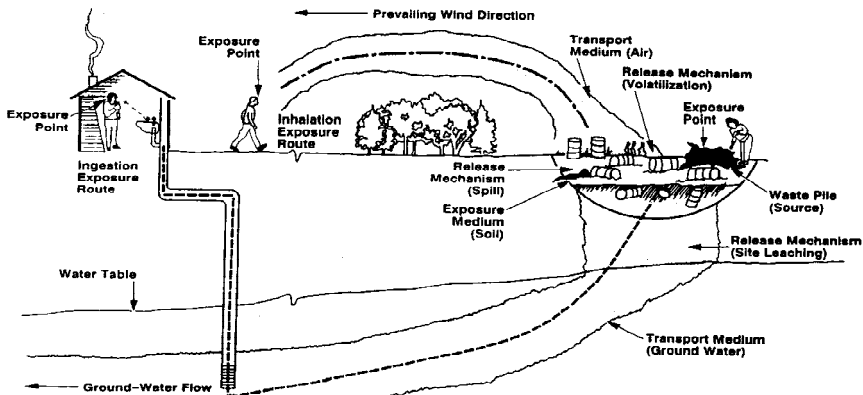


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Exposure Pathways



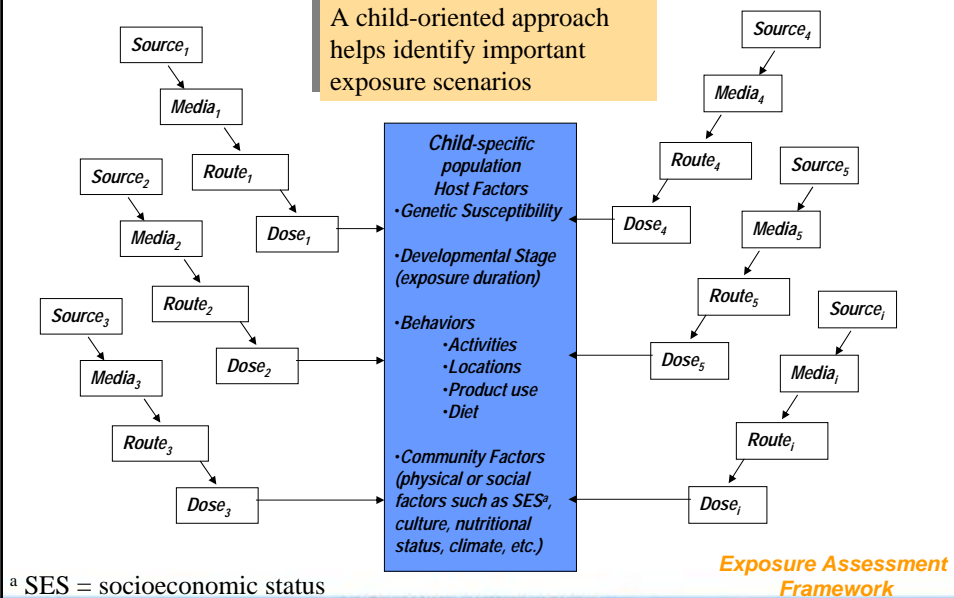
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Child Oriented Conceptual Exposure Model

A child-oriented approach helps identify important exposure scenarios



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Review of Available Data

- Chemical data
 - Sampling
 - Fate and transport models
 - Biomonitoring data
- Developmental-stage specific behavior and physiology
 - **Child-Specific Exposure Factors Handbook**
 - Site-specific surveys
 - **Consolidated Human Activity Database**
- Variability due to ethnic, cultural, racial, socioeconomic factors
- PB/PK Models

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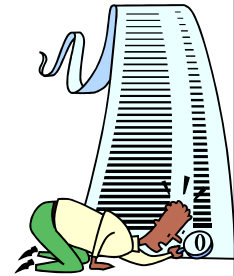


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Child-Specific Exposure Factors Handbook

Contents

- Breast milk intake
- Food intake
- Tap water intake
- Soil ingestion
- Mouthing behavior
- Inhalation rates
- Surface area
- Soil adherence
- Activity factors
- Consumer products
- Body weight
- Life expectancy



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Example: Summary of Mouthing Frequency Data

Age (months)	Mouthing Frequency/Time	Population Size	Reference
3-6	37 min/day	5	Groot et al. 1998
6-12	44 min/day	14	
12-18	16 min/day	12	
18-36	9 min/day	11	
24-72	9.5 contacts/hr (hand to mouth) 16.3 contacts/hr (object to mouth)	30	Reed et al. 1999
30 – 50	9 contacts/hr	4	Zartarian 1997
10-60	55 min/day	92	EPA analysis of
<24	81 ± 7 contacts/hr	28	Davis 1995
>24	42 ± 4 contacts/hr	44	

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Table 5-18. Summary of estimates of soil ingestion by children

Soil ingestion (mg/day)									References
Mean					Upper percentile				
Al	Si	AlR	Ti	Y	Al	Si	Ti	Y	
181	184				584	578			Binder et al., 1986
230		129							Clausing et al., 1987
39	82		245.5						Davis et al., 1990
64.5 ^a	160 ^a		268.4 ^a						
153	154		218.0	85	223	276	1,432	106	Calabrese et al., 1989
154 ^a	483 ^a		170.0 ^b	65 ^a	478 ^a	653 ^a	1,059 ^a	159 ^a	
122	139			165	254	224	279	144	Stanek and Calabrese, 1995a
133 ^c			271.0						Stanek and Calabrese, 1995b
69–120 ^c									Van Wijnen et al., 1990
66 ^b					280 ^b				Calabrese et al., 1997
196 ^a					994 ^a				
Average: 138 (soil) 193 (soil and dust combined)					358 (soil) 790 (soil and dust combined)				

^a Soil and dust combined

^b Best tracer method

^c Limited tracer method; corrected value

Developmental Life Stages and Age Groups for Exposure Assessments

Life Stage	Age Group
Preconception	Reproductive age adult
Prenatal	Conception to birth
Infant	Birth to <1 month 1 to <2 months 2 to <3 months 3 to <6 months 6 to <12 months
Child	1 to <2 years 2 to <3 years 3 to <6 years 6 to <11 years
Adolescent	11 to 16 years 16 to <21 years ^a

^a To be considered in a case-by-case basis

Analysis Approach

- Approach depends on the purpose of the assessment
- Tier approach
 - First tier – screening level to identify bounding exposures
 - Second tier – to understand potential range of exposure
 - Advanced level – to provide increased level of detail

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First Tier Approach

- To identify important pathways
- To rule out insignificant pathways
- Deterministic approach
- To identify potential exposure levels
- To provide bounding estimates
- To identify data gaps

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Second Tier Approach

- More detail pathway analysis
- Refined assessment of important scenarios
- Develop ranges of exposure
- Identify significant data needs

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Third Tier Approach

- Advanced level
- Usually involves probabilistic techniques
- Increased level of detail
- May require collection of new data
- May require application of sophisticated modeling tools

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Methods of Quantifying Dose

- Point of contact - measures the chemical concentration at the interface between a person and the environment.
- Reconstruction of Dose - measures chemical or other indications of change and relates these measurements back to internal dose or exposure.
- Scenario Evaluation - method separately estimates chemical concentrations in the media contacted, activities of exposed individuals or populations, and the time of exposure, then links these through definition and evaluation of “scenarios”.

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Characterization of Variability and Uncertainty

- Results communicated in clear and concise manner
- Describe data limitations and uncertainties
- Ranges or distributions of exposure
- Identify data needs
- Distinguish between uncertainty and inter-individual variability
- Probabilistic assessments may be useful statistical tools for analyzing variability and uncertainty

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Conclusions

- Children's activities and behaviors may put them at different risk than adults from environmental exposures
- Considering a life stage approach can ensure that important pathways of exposure and critical windows of susceptibility are not ignored



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Future Plans

- Research to fill data gaps in exposure factors
- Update Child-Specific Exposure Factors Handbook
- Guidance on Selecting the Appropriate Age Groups for Assessing Childhood Exposures to Environmental Contaminants
- Supplemental Guidance for Assessing Cancer Susceptibility from Early-Life Exposure to Carcinogens
- A Framework for Assessing Health Risks Resulting from Exposures to Children

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NCEA Applying science to improve risk assessment and environmental decision making

Selected TOPICS

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Associated Programs
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Recent Additions

Jan. 16, 2004 Draft of EPA's Project Risk Plan for Air Quality Criteria for Lead

Dec. 22, 2004 Framework for Managing Details Risk Assessment (General Review Draft)

Oct. 15, 2004 Exposure and Human-Health Assessment of 2,2,3,3-Tetrahydrobenzo-*a*-Dioxin (TCDD) and Related Compounds Federal Agency Science (FAS) Review Draft

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Last Updated on Thursday, September 30, 2004
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