Asthma: A Multi-factorial Disease Requiring Multi-Level Interventions

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Primary Prevention of Asthma: A Symposium
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Asthma: a complex disease(s)

- Common signs and symptoms: airway narrowing, wheeze, cough, shortness of breath
- Different kinds of asthma; pathophysiology varies
  - Sensitizer-induced asthma (antibody-mediated)
  - Irritant-induced asthma
  - Mixed
- Implications for primary prevention differ
The origins of asthma

• Many contributing, multi-level, causal risk factors

• A systems problem
  – A group of interacting, interrelated, or interdependent elements forming a complex whole
## System characteristics

<table>
<thead>
<tr>
<th>Simple</th>
<th>Complex</th>
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<tbody>
<tr>
<td>Homogeneous</td>
<td>Heterogeneous</td>
</tr>
<tr>
<td>Linear behavior</td>
<td>Interactions; feedback loops</td>
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<tr>
<td>Deterministic</td>
<td>Non-linear behavior</td>
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<tr>
<td>Static</td>
<td>Causal cascades</td>
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<tr>
<td>Lack feedback loops</td>
<td>Dynamic</td>
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<td>Tipping points (system behavior changes)</td>
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<td>Acquire emergent properties not predictable from</td>
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<td>individual parts</td>
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<td>Resilience, vulnerability</td>
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Complex system models

• Lend themselves to organization of facts in terms of principles
• Suppress a certain amount of detail
• Can be used for a variety of purposes; no single formal model will serve all purposes
Examples

- Causal loop model: Foresight obesity model
- High-level; mapping dimensions of asthma
Foresight Tackling Obesities: Future Choices Project

• Attempts to capture some of the features of a complex problem: the origins of childhood obesity
  
  www.bis.gov.uk/assets/foresight/docs/obesity/17.pdf

• A visual representation of dynamic interrelationships
Importance of physical need for food

Conscious control of energy accumulation

Effort to acquire energy

Strength of lock-in to accumulate energy

Tendency to preserve energy

Level of available energy

Foresight obesity model
Why do this?

• to acknowledge, communicate complexity
  – The anatomy of a system map confirms the multi-level, systemic nature of the problem
  – This highlights the need for broad and diversified efforts to study and change the dynamics of the system.

• to make sense of complexity.
  – constructing or studying a causal loop model helps in understanding the system
  – Once the top-level architecture of a model is grasped, it becomes a filter for identifying relevant variables and an aid to thinking about the further study and interventions
Why do this?

• to support the development of strategies to study and intervene
  – Study of a causal loop model suggests ways and places to intervene most effectively in the system.
  – These are: leverage points, feedback loops, and causal cascades, among others
Asthma: Lifecourse perspective

- Stress markers
- Inflammation
- Immune system, lung development

Childhood asthma

- TOXICANTS
- INFECTIONS
- NUTRITION
- GENETICS
- SOCIAL ENVIRONMENT

Adult asthma
Ecological (eco-social) framework

Multi-level “nesting”
The ecological framework

- Ecosystem
- Societal
- Community
- Family
- Relationship
- Individual

Individual
- Tissue, organ
- Cell
- Organelle
- Cell signaling; biochemistry
Asthma: Ecological Model

**Multiple levels; nested**

**Multiple variables**
- Genetic background
- Toxic chemicals, environmental pollutants, pharmaceuticals
- Exposures to biologic agents; Infectious illnesses
- Nutrition
- Intestinal microbiome
- Vitamin D status
- Housing
- Socioeconomic status
- Prolonged, unusual stress
- Racial/ethnic disparities
- Community safety, assets, services
- Access to food, health care
- Etc.
Time - timing of exposures or events
- duration
- latency
- personal lifespan, aging
- recent historical time (decades, century)
- evolutionary time

Multiple variables

Ecological Model (Ecosocial)

Multiple levels
Summary

• Asthma is a complex disease(s)
• Complex systems
  – Cannot be understood in fine, granular detail
  – Cannot be tightly managed; rather, we interact with them in ways that foster outcomes as close to what we want as possible
  – Will always require acting with some degree of uncertainty
Summary

• This conference and most research use a risk factor approach, but we should keep the complex, multi-level systems model in mind

• Understanding the origins of asthma and intervening to prevent the development of clinical disease will require multi-disciplinary and multi-level strategies and policies