The Impact of Mouse Allergen on Asthma

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Inner-city Childhood Asthma

Asthma Hospital Discharge Rates 1980-2006

- Inner cities are low-income areas in the center of cities
- Race/ethnic minorities often comprise majority of residents in inner-cities
- Asthma prevalence rates 25-28% in inner-cities

Source: National Hospital Discharge Survey, CDC National Center for Health Statistics, *First-listed diagnosis, A Age-adjusted to 2000 U.S. population

Inner-city Childhood Asthma: An Environmental Problem
Cockroach Allergen Exposure and Asthma Morbidity in Inner City Children

- Hospitalizations
- Unscheduled Medical Visits
- Change in Care Giver’s Plans
- Days With Changed Plans

<table>
<thead>
<tr>
<th>Skin Test</th>
<th>Low Allergen Exposure</th>
<th>High Allergen Exposure*</th>
</tr>
</thead>
<tbody>
<tr>
<td>neg</td>
<td>neg</td>
<td>neg</td>
</tr>
<tr>
<td>pos</td>
<td>pos</td>
<td>neg</td>
</tr>
<tr>
<td>pos</td>
<td>pos</td>
<td>neg</td>
</tr>
</tbody>
</table>

Bla g 1 > 8 U/gram

Rosenstreich NEJM 1997

Mouse Biology and Behavior

- *Mus musculus*
  - Order Rodentia—incisors
  - 4-8 pups/litter, 6-8 litters/year
  - Jump 1’ up, 8’ down
  - Run up vertical surfaces
  - Squeeze through holes ¼ inches in diameter
  - Good swimmers
  - Prefer seeds and grains
  - Mus m 1 found in hair, dander, and urine
  - ~90% of Mus m 1 found on particles ≤10 microns

Image courtesy of Rivard's Resources: IPM
## Prevalence of Mouse Allergen

<table>
<thead>
<tr>
<th>Location</th>
<th>Study</th>
<th>Popul’n</th>
<th>Room</th>
<th>% detectable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner-City</td>
<td>NCICAS Phipatanakul et al., JACI, 2000;106:1070-4</td>
<td>608 children</td>
<td>kitchen, BR, or LR</td>
<td>95%</td>
</tr>
<tr>
<td></td>
<td>Baltimore Matsui et al.,JACI,2005;115:358-363</td>
<td>100 children</td>
<td>kitchen</td>
<td>100%</td>
</tr>
<tr>
<td>US Housing/Suburban</td>
<td>United States Cohn et al., JACI, 2004;113: 1167-1171</td>
<td>831 housing units</td>
<td>kitchen, BR, or LR</td>
<td>82%</td>
</tr>
<tr>
<td></td>
<td>Suburban Maryland Matsui et al., JACI, 2004; 113:910-5</td>
<td>335 children</td>
<td>kitchen</td>
<td>75%</td>
</tr>
</tbody>
</table>

## Mus m 1 Levels Highest in Inner-city Homes

<table>
<thead>
<tr>
<th>Study Population</th>
<th>Median Kitchen Mus m 1 (μg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suburban Maryland</td>
<td>.007</td>
</tr>
<tr>
<td>US sample (Cohn JACI 2004)</td>
<td>0.36</td>
</tr>
<tr>
<td>NCICAS (Phipatanakul JACI 2000)</td>
<td>1.6</td>
</tr>
<tr>
<td>Inner-city Baltimore</td>
<td>14.7</td>
</tr>
</tbody>
</table>

- Detectable in air of 84% of bedrooms
- 25% homes with levels similar to occupational levels

## Sensitization to Mouse

<table>
<thead>
<tr>
<th>Study Population</th>
<th>Study Population</th>
<th>+ mouse SPT/IgE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupational</td>
<td>Matsui Annals 2004</td>
<td>151 adults</td>
</tr>
<tr>
<td>NCICAS</td>
<td>Phipatanakul JACI 2000</td>
<td>499 children</td>
</tr>
<tr>
<td>ICAS</td>
<td>Gruchalla JACI 2005; Pongracic Annals 2008</td>
<td>937 children</td>
</tr>
<tr>
<td>Baltimore</td>
<td>Matsui Annals 2006; Matsui AAAAI 2011, 2012</td>
<td>150 children</td>
</tr>
<tr>
<td>West Virginia</td>
<td>Welch Annals 2003</td>
<td>209 children</td>
</tr>
<tr>
<td>Suburban Maryland</td>
<td>Matsui JACI 2004</td>
<td>335 children</td>
</tr>
</tbody>
</table>
Mouse Allergen Exposure is Associated with Asthma Morbidity

- 2-6 year old Baltimore children with asthma
- Comparison of mouse sensitized and exposed to those who were either not sensitized or not exposed
- 9/10 hospitalizations occurred among sensitized/high exposure group
- Adjusted for age, sex, atopy, cockroach sensitization and exposure, public health insurance, and study visit

Pest Allergen Exposure and Morbidity

Study population Characteristics | N=150
--- | ---
Male | 57 %
Public Insurance | 85%
Black | 91%
Atopic | 91%

<table>
<thead>
<tr>
<th>Allergen</th>
<th>Sensitized (+SPT)</th>
<th>Sensitized and Exposed*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat</td>
<td>64%</td>
<td>10%</td>
</tr>
<tr>
<td>Roach</td>
<td>60%</td>
<td>41%</td>
</tr>
<tr>
<td>Mouse</td>
<td>51%</td>
<td>41%</td>
</tr>
<tr>
<td>Mite</td>
<td>56%</td>
<td>9%</td>
</tr>
</tbody>
</table>

*Cat: 8mcg/g  
Cockroach: 1U/g  
Mouse: 1mcg/g  
Dust mite: 2mcg/g

Higher levels of mouse allergen in the bed was more strongly associated with an acute visit.

Allergen-Specific IgE Levels: Marker of Exposure and Sensitization

Matsui et al, Allergy 2010  
From the Inner-City Asthma Consortium
**Integrated Pest Management**
- Assess & modify facilitative factors
- Routes of ingress
- Sources of food, water
- Assess infestation
- Location(s) of greatest activity
- Source control:
  - traps
  - rodenticide if necessary

**IPM Is Successful in Reducing Mouse Allergen Levels**

![Graph showing reduction in Mus m 1 levels over time](image)


**Integrated Pest Management Intervention: What Went Wrong?**

- N=150/155
  - asthma
  - +SPT
- Rodent module
  - Traps, education, air filters
- Change in BR floor Mus m 1
  - -27% vs. +28%

*Pongracic J, Ann Allergy Asthma Immunol 2008*
Mouse Allergen and Asthma Intervention Trial

Study Procedures for all Participants

Mouse Allergen and Asthma Intervention Trial

Randomization

HV

HV

HV

HV

Education Group

IPM Group

IPM Modules delivered if persistent/recurs

Figure 7: MAAIT Study Scheme

NIAID-funded
Clinical Site/Core Leaders: Elizabeth Matsui; Matt Perzanowski; Wanda Phipatanakul

Mouse Allergen Exposure in Schools

Fig 1  Settled dust geometric mean levels of Can f 1, Fel d 1, and Mus m 1 in all samples (school vs. home). 7 tests were performed on logged values. *p = 0.0002, **p = 0.0012, ***p = 0.0001.

Permaul et al Pediatr Allergy Immunol 2012

Inner-city Asthma: Home-based Environmental Intervention

Figure 1. Mean maximal number of days with symptoms for every two-week period within a follow-up assessment during the two years of the study. The difference between the groups was significant in both the intervention year (P=0.0001) and the follow-up year (P=0.001).

Morgan, NEJM 2004
What About Costs?

- **Medication Costs**
  - fluticasone/salmeterol
    - 500/50 = $275/month = $3300/y
    - 250/50 = $215/month = $2580/y
    - 100/50 = $175/month = $2100/y
  - montelukast = $125/month = $1500/y
- **Cost of environmental intervention** (Morgan et al NEJM): ~1500 dollars/family

Conclusions

- Mouse allergen is prevalent everywhere with the highest levels in the inner city (100-1000 fold higher)
- Mouse allergen is associated with worse lung function, pulmonary inflammation, and morbidity in mouse-sensitized
- Integrated pest management can reduce allergen levels
  - ? may improve asthma
- Questions for the future:
  - Are community-level interventions feasible and effective?
  - What is intervention worth compared to medications?
  - Does environmental control modify the natural history of asthma?