**What are the Effects of Indoor Bioaerosols on Asthma?**

**How Do We Measure Exposure and Manage Risk?**


**Contributing Organizations:** ORD, NHEERL, NERL, NMRC, Office of Air and Radiation

**RESEARCH TRIANGLE PARK, NORTH CAROLINA JANUARY 13-15 2009**

**Research Goals**

1. To develop a method to identify and quantify indoor mold exposure and risk
2. To assess the allergic potential of various indoor molds using a mouse model of allergy/asthma
3. Determine dose-response
4. Compare to well characterized indoor allergens (house dust mite)
5. Characterized potential mold allergens
6. Extrapolate data from mouse to man

**Methods/Approach**

- **Developed PCR-based method of mold identification and quantification (MISOPCR)**
- **100 homes surveyed by the National American Healthy Home Survey (participated in HUD)**
- **Developed the Environmental Relative Moldiness Index (ERMI)**
  - Molds have varying potential to induce allergic or asthma-like responses in the mouse model
  - Allergic responses to mold extracts occur in a dose-response manner (threshold dose)

**Impact and Outcomes**

- **Ongoing research addresses indoor environment research needs identified in the Indoor Environments Division document Program Needs for Indoor Environments Research (PNER)**
- **ERMI scale describing household mold burden used in epidemiological studies**
  - Cleveland, Cincinnati, Chapel Hill, Detroit, Baltimore and New Orleans (and an association of higher ERMI values with increased asthma-related symptoms reported)
  - U/V/HVAC studies led to GAO requiring that all new GAO buildings be equipped with UV-capabilities in their HVAC systems
  - The ESTE product verification system can be used by building professionals and consumers to make informed decisions regarding the use of building products
  - **The mold research has provided Congress (GAO Review on Indoor Mold) with insight into the current state of the science regarding indoor mold. GAO identified a need for more mold research**

**Microbial Resistant Product**

- **Use of Microbial resistant products may have unintended consequences** (e.g. producer unobtained levels of VOCs)
- **EPA Environmental and Sustainable Technology Evaluation (ESTE) system**
  - Test method developed to verify materials performance according ACS guidelines
  - Maintenance products (ASTM D5150)
  - Fungi/mold resistant (ASTM D229-98)
  - VOC emissions (ASTM D 511a)

- **Rustan based industrial stakeholder group determine the optimum testing procedures**

**ERMI APPLICATIONS**

- **Cincinnati County**
  - **Higher ERMI values in asthma homes**
  - **Remodeling of mold and moisture = less asthma symptoms**
- **EPA Regional Offices**
  - **Office of Indoor Air**
  - **Office of Children’s Health Protection**

**Future Directions**

- **Developed the Environmental Relative Moldiness Index (ERMI)**
  - A mold research has provided Congress (GAO Review on Indoor Mold) with insight into the current state of the science regarding indoor mold. GAO identified a need for more mold research

**Extrapolation from Mouse to Man**

- **Mouse model Dose-Response**
  - Allergic asthma-like endpoints in a dose-response manner with a threshold dose
  - Airway reactivity without significant allergic responses
  - Neither allergic nor airway responses

**Molds**

- **Human sera IgE reacts with mouse not commonly recognized by human sera**
- **Mouse allergen specific IgG and IgE were associated with IgE sensitization**

**Endotoxin**

- **Potential Mechanism of Enhanced Response**
  - Examination of airway cells recovered from allergic asthmatic volunteers after challenge with low endotoxin (10,000 EU/μg)
  - Higher levels of TNF, C3b and IL-β in-DR (induced allergic presentation in murine lymphocytes) in macrophages and monocytes
  - Eosinophilic airway inflammation
  - in IgE bearing cells after allergen challenge

**Findings and Conclusions**

- **Cross-queries fungal protein allergens may provide environmental assessment biomarkers**
- **Similar IgE-reactive protein profiles are detected by human and mouse sera**
- **Methods have been developed for testing the efficacy of microrial resistant building products**
- **Endotoxin, identified in both blood and tissue medium and increased in allergic asthmatic volunteers**
- **Endotoxin at environmental exposures levels increased cell surface markers engaged in allergic presentation and increased levels of IL-12 after allergen challenge**
- **Mouse allergen exposure is common among suburban, middle-class asthmatic children as well as inner city asthmatic children**
- **High levels of mouse allergen exposure in children may be associated with attenuated humoral responses of all isotypes.**

**Susceptible Populations**

- **Kerrigan et al. Reduction in asthma morbidity in children as a result of home remediation aimed at moisture sources. Environ Health Perspect, 2006, 11(4):1754-60.**
- **Ward et al. Human sera IgE reacts with a Metarhizium anisopliae/fungal cathepsin. Submitted**
- **Zaltis et al. How exposures to biotoxins influence the induction and incidence of asthma. Environ Health Perspet, 2006, 114(s):392-6.**

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**Science Questions**

- What is the role of dampness and/or mold exposure in the induction/exacerbation of asthma?
- How can we assess exposure to biotoxins in this population of interest?
- How can we accurately assess the health effect of mold exposure in populations?
- Does epidemiology identify other important (and understudied) bioaerosols associated with asthma?