

**INDOOR ALLERGENS AND IRRITANTS:  
WITH EMPHASIS ON MOLDS IN THE  
ASSESSMENT OF INDOOR QUALITY  
COMPLAINTS**

**Emil J. Bardana, Jr., M.D.  
Oregon Health Sciences  
University**

# INTRODUCTION (1)

- Homes protect inhabitants from the elements, but not from the effects of indoor pollutants
- 80-90% of our time is spent indoors
- Health consequences of indoor pollutants depend on number and concentration of point sources

## INTRODUCTION (2)

- Quality of indoor air depends both on the quality of outdoor air and nature and strength of indoor pollution sources
- Sources of indoor pollution include outdoor air, biological exposures, chemical exposures and occupant activities

# PATHOGENESIS OF ENVIRONMENTAL DISEASE

- Immunologic: IgE, IgG or T-cell mediated
- Irritational effects: chemicals, endotoxin, glucans, etc.
- DEP effecting allergic response

# NOMENCLATURE

- Problem building or home
- Building-related illness
- Sick building (home) syndrome
- Crisis building or home

# **PRECIPITATING EVENTS**

- Rapid new building occupancy
- Building (home) renovation
- Water incursion with mold contamination

# **COMMON CLINICAL** **OUTCOMES**

- Irritational syndromes
- Sensitization (IgE-mediated)
- Infection (extremely rare)
- Mycotoxicosis (ill-defined)
- Psychogenic illness (toxic agoraphobia)

# ALLERGIC SENSITIZATION

- A. Housedust mite
- B. Cat, dog, birds
- C. Cockroach
- D. Rodents
- E. Fungi



## A. HOUSEDUST MITE (1)

- Small (0.3 microns) arachnids that reside in the dust that accumulate in bedding, carpets, fabrics, furnishings, etc.
- Most common species in N.A. and Europe Dermatophagoides farinae & D. pteronyssinus

## A. HOUSEDUST MITE (2)

- Prevail in coastal areas with high humidity; major allergens are cysteine proteases Der p 1 and Der f 1
- Sensitization to h.d. mite strongly associated with increased BHR & asthma
- 2 µg of Der p 1: Sen; 10 µg of Der p 1: acute asthma

## **B. CAT AND DOG ALLERGENS (1)**

- Prevalence of pets in homes is estimated at 30-40%; similar for sensitized and non-sensitized patients
- Prevalence of sensitization to cat allergen (Fel d 1) estimated at 2% of population and 50% of asthmatic children
- Produced by all breeds of cats

## **B. CAT AND DOG ALLERGENS (2)**

- Extremely buoyant; airborne for many hours; often found in dust from public buildings
- 8  $\mu\text{g}$  of Fel d 1 per gm of dust assoc. with Sxs; such levels have been found in schools and homes where there are no cats

## **B. CAT AND DOG ALLERGENS (3)**

- Dog is a more popular pet
- Sensitivity differences may relate to antigen, washing and outdoors
- Can f 1: breed specific allergens

## C. COCKROACH ALLERGEN

- Of many species in the world, American cockroach (Perplaneta americana) and the German variety (Blattella germanica) predominate in the U.S.
- Sensitization highest in crowded, urban homes with heavy infestation; found in kitchen cabinets, floor dust and bathrooms

## D. RODENTS (1)

- Variety of species are house pets, eg., hamsters, gerbils, etc.
- Significant occupational allergen
- Mouse allergen very prevalent among inner city homes

## D. RODENTS (2)

- Allergen detected in over 95% of homes studied
- More prevalent than dust mite and cat allergens
- Related to sensitization but not de novo development of asthma



## E. FUNGI (1)

- Fungi are ubiquitous in the environment
- There are over 100,000 species (1.5M)
- Indoor air generally 30-70% of outdoors
- Outdoor counts extremely variable; can swing from 10 to 10,000 cfu/m<sup>3</sup> in hours

## E. FUNGI (2)

- An analysis of published fungal measurements in and outdoors revealed an average indoor conc in 820 non-complaint homes to be 1,252 cfu/m<sup>3</sup> with an average outdoor level of 1524 cfu/m<sup>3</sup>

## E. FUNGI (3)

- There are no numeric standards for airborne or surface fungi indoors
- There is no uniformity in the suggested guidelines for indoor air fungi
- There is no known dose-response relationships with respect to health effects

## E. FUNGI (4)

- Ecology of fungi vary
- Some flourish in high water, eg., Acremonium, Chaetomium, Fusarium, Rhodotorula, Stachybotrys
- Some are xerophilic, eg., Eurotium, Wallemia, etc.
- Xerotolerant, eg., A. sydowii, A. veriscolor, Penicillium

## E. FUNGI (5)

- Acremonium, Fusarium, Trichoderma, Stachybotrys produce slimy spores - dispersed by water, insects, animals
- Basidiomycetes, Cladosporium, Alternaria frequently found outdoors
- Basidiomycetes grow on water-damaged wood products

## E. FUNGI (6)

- Finding fungi in a home/apt. not evidence of occupant exposure or an adverse health effect
- Insight achieved by comparing fungal types/species outdoors to indoors and between complaint and non-complaint homes/apt.

## E. FUNGI (7)

- Quantitative sampling for indoor fungi is complex, difficult and variable
- Most common indoor species:  
Cladosporium, Aspergillus, Penicillium,  
Aureobasidium and Alternaria

## E. FUNGI (8)

- Reports from sawmills where there are no worker complaints reveal fungal conc. as high as 2.5M cfu/m<sup>3</sup>
- Measurement in non-complaint farms (barns/stables) as high as 120 M spores/m<sup>3</sup>
- Mushroom farms in NW, indoor conc. Are regularly 100,000 spores/m<sup>3</sup>



## E. HEALTH EFFECTS/FUNGI (9)

- Irritational (VOCs, glucans, proteases)
- Allergic sensitization
- Infection (compromised host)
- Mycotoxicosis (proven clinical correlates rare)
- Psychogenic (fueled by the media, i.e., cyberchondriacs)

## E. HEALTH EFFECTS/FUNGI (10)

- Paucity of data precludes estimation of a risk level for symptom exacerbation (or even defining a high level)
- It is important to segregate engineering/building issues from perceived health issues

# E. FUNGI (11)

## STACHYBOTRYS

- Focus of public concern...“the fatal fungus”
- Minor component of indoor microflora, found in cellulose under conditions of high humidity and low nitrogen content
- Associated with Aspergillus, Cladosporium and Alternaria

## E. FUNGI (12)

### STACHYBOTRYS

- Greenish-black, sooty-looking, saprophytic mold
- Hard to isolate in undisturbed indoor air
- Contaminant of agricultural produce; cultured from soil, hay, straw, grains, and mammalian fur

## E. FUNGI (13) STACHYBOTRYS

- Infection: never reported
- Allergy: No proven case exists
- Toxicity: Skin contact, inhalation
- Ingestion: “Alimentary toxic aleukia”

## E. FUNGI (14)

### STACHYBOTRYS

- 2 major clinical presentations: 1) “subjective health complaints”; 2) pulmonary hemorrhagic alveolitis in infants
- Cleveland geographic cluster of 10 cases in infants 1-8 mos old (Jan 93-Dec 94)
- Stachybotrys mycotoxin incriminated

## **E. FUNGI (15)**

### **STACHYBOTRYS**

- Clear discrepancy between public/media perception and current available scientific and clinical evidence concerning possible toxic effects
- Extremely doubtful there would be sufficient exposure to cause illness, even if the recovered fungus is able to produce a relevant mycotoxin

# **NON-ALLERGIC, IRRITANT- INDUCED INDOOR AIR QUALITY PROBLEMS**



# 1. COMBUSTION PRODUCTS: CARBON MONOXIDE

- Odorless, colorless and tasteless gas
- An asphyxiant with high affinity for Hgb.
- Half-life in the body ranges from 2.5-4.0 hrs
- Non-smokers 0.5%; smokers 4-10%
- Non-irritating, but it does displace O<sub>2</sub>

## 2. COMBUSTION PRODUCTS: NITROGEN DIOXIDE

- Oxidant gas which is soluble in tissues
- Inhaled  $\text{NO}_2$  retained in the lungs - primarily in the airways
- Combines with  $\text{H}_2\text{O}$ : nitric & nitrous acids. May impair lung defense mechanisms
- Minimal health implications in the healthy

### 3. COMBUSTION PRODUCTS: FORMALDEHYDE

- Pungent, highly reactive chemical that is soluble
- Cross-links with many organic chemicals

## 4. COMBUSTION PRODUCTS: FORMALDEHYDE

- Ubiquitous in homes, offices and the general urban environment
- Impacts respiratory health by its irritant nature, unlikely to induce symptoms as a respiratory allergen

## 5. VOLATILE ORGANIC COMPOUNDS (VOCs)

- Contain at least one carbon & a hydrogen atom
- Low boiling point; easily off-gas vapors
- Present in building products, paints, adhesives, furnishings, carpets, etc.
- Concentrations of TVOCs in excess of 0.1 ppm may cause transient airway irritation

## **6. ENVIRONMENTAL TOBACCO SMOKE (ETS)**

- Between 40-45 M American adults smoke
- Between 50-75% of children's homes have at least one smoker
- ETS contains > 3800 chemicals - most are potent irritants

## **7. ENVIRONMENTAL TOBACCO SMOKE (ETS)**

- Respirable particulate matter is 2-3x higher in homes with smokers
- Increased rates of respiratory illness

# SUMMARY 1

Indoor environments dominate the exposure spectrum since people spend most of their time indoors



## SUMMARY 2

- Fungal constituents are only one small part of the indoor air quality spectrum that can effect health
- We often lose sight of the many other factors which are perfectly plausible explanations for symptoms attributed to molds