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

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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

• Irrititational 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 µg 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/m³ 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$^3$ with an average outdoor level of 1524 cfu/m$^3$. 
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/m³
- Measurement in non-complaint farms (barns/stables) as high as 120 M spores/m³
- Mushroom farms in NW, indoor conc. Are regularly 100,000 spores/m³
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 $O_2$
2. **COMBUSTION PRODUCTS: NITROGEN DIOXIDE**

- Oxidant gas which is soluble in tissues
- Inhaled NO$_2$ retained in the lungs - primarily in the airways
- Combines with H$_2$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.
• 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