Testing Method for Reduction of Airborne Pet Allergens by Liquid Spray Application

Mike Van Dyke, CIH, CSP, John Martyny, Ph.D., CIH, Shawn Arbuckle, Lisa Barker, and Jay Westcott, Ph.D.

National Jewish Medical and Research Center

Denver, CO
(303)398-1034
vandykem@njc.org
Background

- 20 million Americans with asthma
- 70% also have allergies
- From 1980-1994 asthma rates increased >160% in children
- Exposure to allergens causes exacerbation of asthma symptoms
- Exposure among children may be contributing factor in asthma development
Pet Ownership and Allergy

- US households
  - 59% own at least one pet
  - 39% own at least one dog
  - 5% own ≥3 dogs
  - 34% own at least one cat

- 17% US residents are allergic to cats

- 67% of households with an asthmatic child own a pet
  (Wamboldt et. al. 2002)

- 83% of pet owners with documented allergies keep pet
Environmental Control Methods

• Elimination
• Substitution
• Engineering controls
  – Control the source
  – Ventilation
  – Wet methods
  – Fugitive dust control
• Administrative controls
Biocides for Allergen Control
(a concept not a recommendation)

- Ability of biocides to denature active allergen proteins in environmental conditions?
  - Interference by organics
  - Contact time/probability of interaction
- Is denaturing enough?
  - Does denatured = non-reactive
- Toxicity of the disinfectants
  - Use in confined spaces
  - Use by sensitive individuals
Lessons from Mold

- Sodium hypochlorite kills *Aspergillus* sp. In solution and on environmental surfaces under laboratory conditions.

- Sodium hypochlorite inhibits antigenicity as determined by ELISA of *Aspergillus* sp. when sprayed on surfaces.

- Skin testing supported the results of the ELISA in 5/8 individuals with bleach and 7/8 using Tilex.
What about pet allergens?

• 300 µL of 3,750 ppm NaOCl reduces dog and cat allergens from 1 mg of dust to below detectable levels by ELISA
Objectives

• Develop a model system to test the interaction between liquid sprays and airborne allergens.
• Test model with hypothesized “positive” and “negative controls” (sodium hypochlorite and water)
Allergen Source

- Dust collected with a household vacuum cleaner
- Composite Dust – California, Colorado, and Alabama
- Dust pre screened and dry sieved - < 32 um (final mass 50 g)
- Dust thoroughly mixed
Allergen Testing

- Find a molecular biologist
- ELISA (Enzyme Linked ImmunoSorbent Assay) test for antigen
- Indoor Biotechnologies kit (Fel d1, Can F1)
  - Includes capture antibody, detector, and calibrated standard
- Method slightly modified
Dust Characterization

- **Cat - Fel d1**
  - Four samples
  - Avg 258 ng/mg
  - Range (234-300)

- **Dog - Can f1**
  - Four samples
  - 85 ng/mg
  - Range (73-95)
Testing System

- One cubic meter plexiglass chamber
- Fluidized bed aerosol generator
- Mixing fan
- Three pumps 15 l/min each
- Real time measurements – particle concentration and relative humidity
Test Chamber

- HEPA filters
- Dust Generator
- Sample Ports
- Spray Port
- Humidity/Temp
- Particle Counter (DustTrak)
Aerosol Generator
Fluidized Bed Generator

- Designed for dry powders
- De-agglomerates particles with brass beads
- 0.5 µm to 40 µm
- Flow rate of 2 l/min

Photo Credit, TSI, inc.
**Dust Collection**

- Three Pumps
  - 15 lpm each
- Critical orifice
- Dust collected on 37 mm, 0.5 µm PVC filters
- Filters combined to one sample for allergen analysis
Dust and Allergen Analysis

- Filters desiccated 48 hours pre and post sampling
- Dry filters weighed on microbalance – accuracy to 100 µg, reproducible to 1 µg
- Filters eluted with distilled water and TWEEN – 2 hours on shaker
- Analyzed by ELISA
- Report as ng allergen or mg of total dust
Other Real-time Instruments

- **DustTrak**
  - 90° Light Scattering
  - 0.1 to 10 µm
  - Output in mass concentration (mg/m³)
  - One sample every minute

- **QTrak**
  - Relative humidity measurement
  - One sample every minute
Sprayer

- Preval Sprayer
- Average output
  - 0.76 ml/minute
Method Evaluation

- No spray
- Water spray
- 3,750 ppm NaOCl spray
- 13 Repetitions each
- Order randomized
- Non-parametric analysis
  - Kruskal-Wallis
  - Dunn’s Multiple Comparison
Test Cycle

- Generator off when pumps on
- Spray liquid using Pre-Val sprayer for 20 seconds (15 mL)
- Wait 40 seconds after spray before turning on pumps
- Control samples – waited 60 seconds
- Total cycle time of 68 minutes
Dust Concentrations
(26 Total Experiments)
Typical Mass and Relative Humidity
Cat Allergen by Treatment

- No Spray
- Water Spray
- NaOCl Spray

P < 0.05

P < 0.01
Dog Allergen by Treatment

- No Spray
- Water Spray
- NaOCl Spray

*can f1 in ng*

- P < 0.05
- P < 0.01
Treatment Conclusions

• Water
  – Reduces Cat by 62%
  – Reduces Dog by 63%

• NaOCl (ref water)
  – Reduces Cat by > 92%
  – Reduces Dog by > 88%
Method Conclusions

• Possible to create a reproducible level of airborne pet allergens in a controlled environment
• Results indicate NaOCl can be used as an acceptable positive control
• Additional work is needed to determine the cause of the discrepancy between allergen levels and total dust levels
  – Near LOD for gravimetric method
  – Better adhesion of particles to filter with liquid spray methods
Limitations

- Tests performed in a controlled environment
- Dust concentrations an order of magnitude higher than would be expected in residential or office environment
- Dust and spray contained by chamber
- Dust sieved and composited—allergen content of actual dust may be higher or lower
- Spray application volume unrealistic for larger space
- Unknown where reaction of allergen and NaOCl occurs—Air vs. Filter
Future Work

- Dose response
- Sprayer changes
- Filter elution testing
- Charge neutralizer
- Coated filters
Questions?