Novel Natural Exposure Chamber Technology Mimics Environmental Allergen Levels Whilst Providing Well-Controlled Airborne Allergen Exposures with High Specificity to Allergic Patients

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Abstract

Rationale: Variable and/or low allergen exposure in traditional field trials results in highly variable allergy symptoms, necessitating large-scale, long-term, risky, and costly clinical trials. A new allergen challenge model, in which the aerosolization method better mimics patients' everyday exposures, whilst isolating the test provocateur and providing tight control of the exposure, is warranted.

Methods: We developed the Natural Exposure Chamber (NEC) in which ragweed pollen is released at a point source within the NEC, similar to how pollen is released in nature, whilst accommodating 50 patients. The wind velocity and direction within the NEC is engineered to suspend and thoroughly mix airborne pollen grains without the use of internal fans providing laminar airflows. A thorough validation protocol with acceptability criteria set out *a priori* was performed in duplicated to establish airflow maps and allergen distributions within the NEC.

Results: The NEC airborne allergen levels were demonstrated to be spatially uniform at both sitting and standing heights within a tolerance of 3000-4000 pollen grains/m³. Temporal uniformity over an 8-hour session was also demonstrated.

Conclusions: The NEC demonstrated uniform allergen distribution across the patient seating area. NEC allergen exposure is isolated from other stimuli such as laminar airflows which provide shear forces to facial and ocular surfaces, and which themselves may provoke symptoms, thereby contributing to non-allergic and/or psychosomatic responses that may confound the symptomatic response. The NEC represents the next generation in environmental exposure chamber technologies in which allergen exposures are highly specific, accurate and precise which will improve research outcomes in allergy.

Introduction

The Natural Environmental Exposure Chamber (NEC) tightly controls the conditions of the test provocateur and the exposure to research subjects, by utilizing but provides a novel aerosolization method which better mimics the natural levels of various allergens in everyday lives. Variable and/or low allergen exposure in traditional field trials results in highly variable allergy symptoms, necessitating large-scale, long-term, risky, and costly clinical trials. Therefore standardization and effective imitation of real life exposures enables scientific rigor in a model that eliminates confounding variables and improves patient compliance. Literature reviews have concluded that EEC's provide an effective patient delivery system that accurately and consistently determines onset of action and efficacy of anti-allergy treatments.[1,2]

Methods

The NEC was designed and engineered to promote the controlled aerosolization of allergen (ragweed pollen) in a consistent homogenous manner. Ragweed pollen was aerosolized from a fixed point source within the NEC, similar to how pollen is released in nature. Pollen sampling occurred at 30 minute intervals using 5 (and 1 roving 6th) individual Rotation Impaction (RI) samplers strategically positioned (Fig.3) to determine pollen measurements across the subject seating area and its periphery. RI samplers were first positioned to sample at the average "head height" of seated subjects, then again at "head height" of subjects standing to demonstrate a spatial pollen distribution within a 3000-4000 pollen grains/m³ tolerance.

A thorough validation protocol with acceptability criteria set out *a priori* was performed in duplicate to establish airflow maps and allergen distributions within the NEC. The objectives included experiments to demonstrate the NEC could achieve and maintain an average ragweed concentration between 3000-4000 pollen grains/m³ capable for a period typical of clinical trials and sustain spatial homogeneity throughout the room regardless of subject placement.


The NEC Model Advantages

**The Natural Environmental Exposure Chamber has:**

- Controlled environmental conditions including temperature, relative humidity, air flow and allergen levels at any time of the year.
- Mimic natural environmental allergen exposure.
- Objective measures within the environment and in real-time.
- Subjective symptoms monitored and maximized.
- 100% compliance.
- Data less variable.
- Ideal model for efficacy studies and PK/PD modeling.
- Less patients required for significance.

Results

Airborne allergen levels across the NEC were demonstrated to be spatially (Fig.1) and temporally (Fig.2) uniform across all 6 RI samplers located throughout the chamber. During clinical trials, subjects moving around the NEC to perform protocol driven measures or take breaks will still experience pollen exposures within the target concentrations as pollen sampling taken from sitting and standing heights fell within tolerance ranges of 3000-4000 pollen grains/m³ across the NEC over an 8 hr. sampling period.
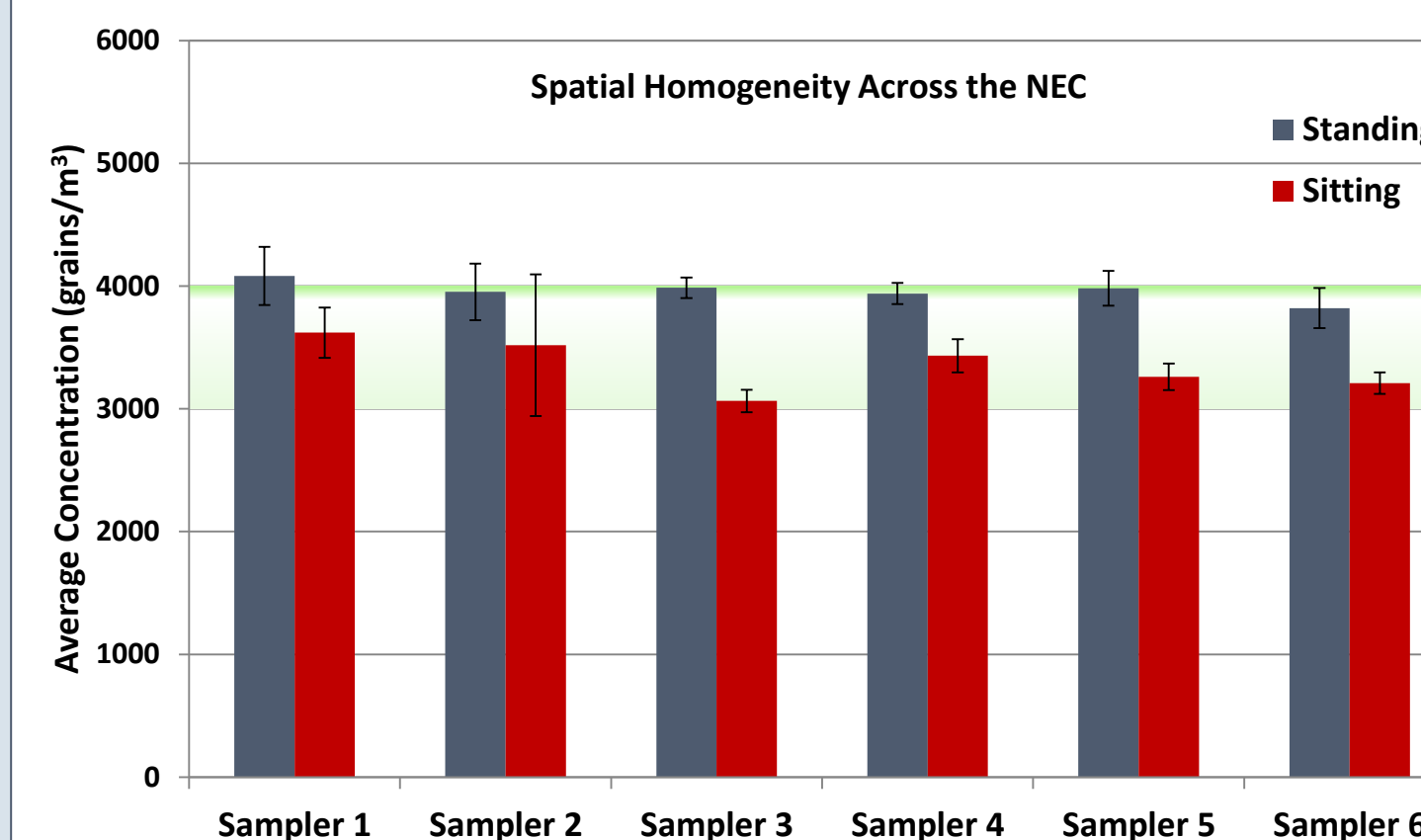
Figure 1. Ragweed pollen grain counts over 4 hours show the average concentration at each sampler regardless of location or height fall within target tolerances demonstrating spatial homogeneity. Error bars represent standard error
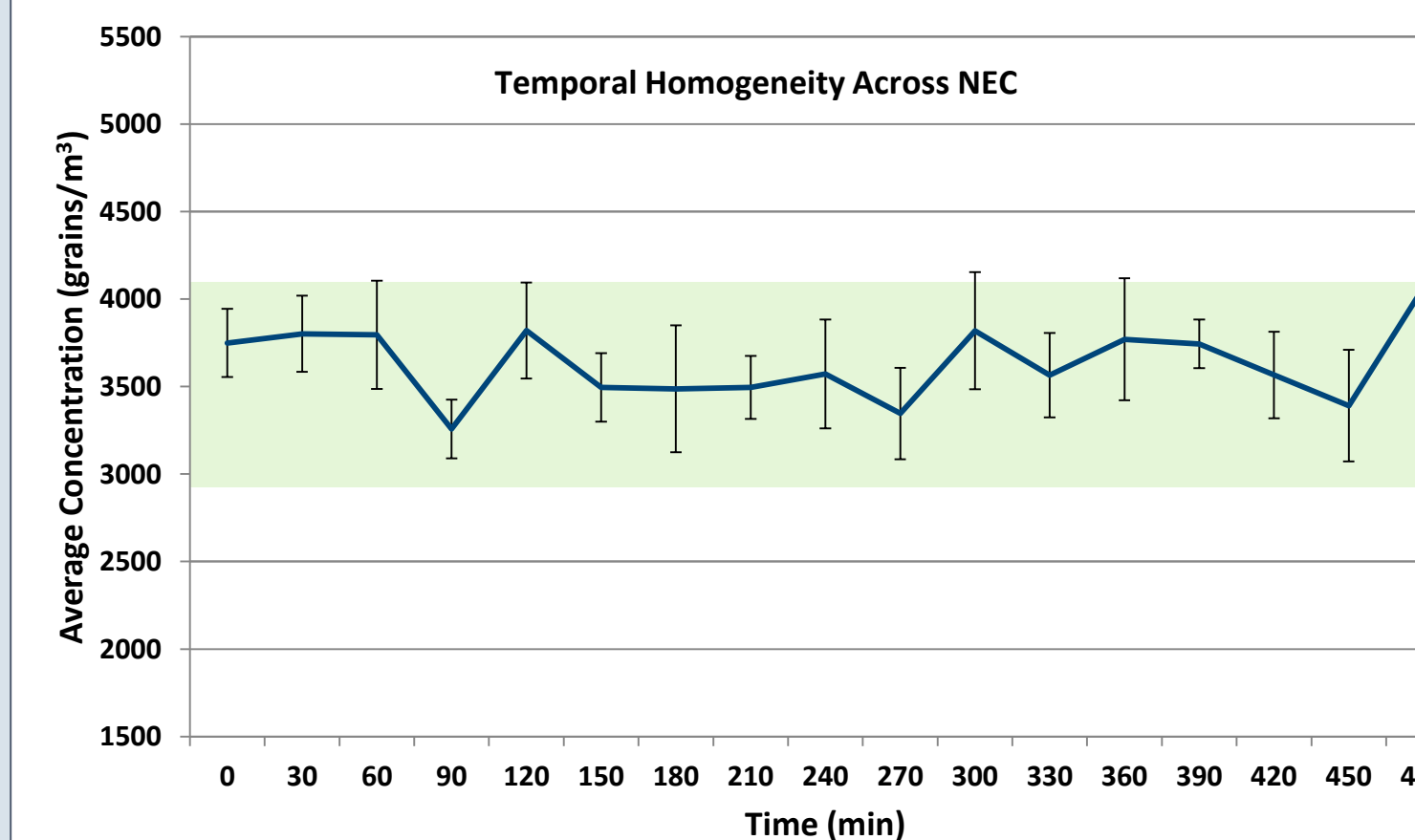
Figure 2. Average pollen grain concentrations (6 samplers) over 8 hours maintain allergen levels within target tolerances demonstrating temporal homogeneity. Error bars represent standard error.
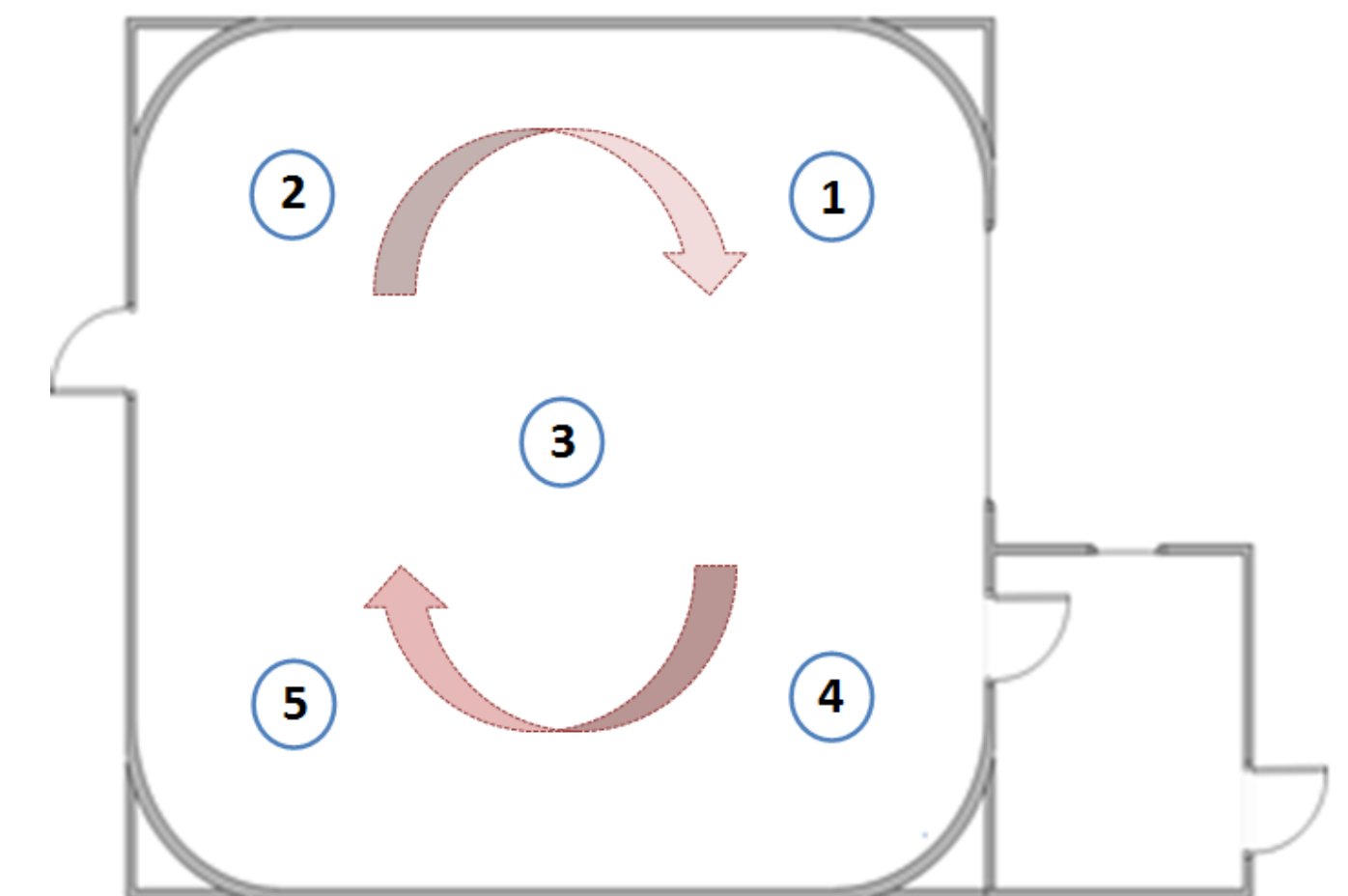
Figure 3. Allergen was aerosolized from a point source within the NEC to allow the uniquely designed air ventilation system to uniformly distribute the pollen grains in a natural manner. The location of the 5 static samplers are depicted. A sixth sampler roved throughout the room.

Conclusions

The NEC demonstrated uniform allergen distribution across the patient seating and peripheral areas. NEC allergen exposure is isolated from other stimuli such as laminar airflows which provide shear forces to facial and ocular surfaces, and which themselves may provoke symptoms, thereby contributing to non-allergic and/or psychosomatic responses that may confound the symptomatic response. The NEC represents the next generation in environmental exposure chamber technologies in which allergen exposures are highly specific, accurate and precise which will improve research outcomes in allergy.

References

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