Rapid Allergenic Particle Identification (RAPID)

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The proposed effort combines air sampling devices and highly-integrated protein microarrays to permit estimation of multiple protein allergen exposures in a time efficient manner. Portable air sampling devices that fit inside the nostrils, and have been used in Australian and European asthma studies, will be used for collection of samples in an ongoing study of inner-city New York homes of children (n=200) with increased risk for developing allergy and asthma. Highly multiplexed protein microarrays, allowing parallel assessment of many allergens, integrated onto active complementary metal-oxide-semiconductor (CMOS) substrates will be employed. The use of CMOS allows highly-integrated and sensitive devices to be developed because of the immediate proximity of the detector to the sensing electronics. As the commodity technology for microelectronics, such active substrates can be produced at very low cost. An established fluorescence based sensor substrate will be employed for initial studies, augmented by simple microfluidic delivery. Biosensor technology development will include efforts toward real-time measurement capabilities including more complex microfluidic delivery (including pressure activated valves), real-time fluorescence sensing through lifetime-sensitive FRET, and CMOS-integrated mass-based biosensors. The same principles for assessment of allergens in air can be applied to assessment of bacterial and fungal pathogens and their constitutive toxins. These studies have far-reaching implications for acute and chronic measures of public health.

The specific aims are as follows:

1) In a sample of 200 homes, field technicians will wear the nasal air samplers (NAS) for 30 minutes while vacuuming dust from the beds of 4 and 5 year old children. The NAS-derived eluate will be analyzed with active CMOS protein arrays (Array F1) with microfluidic delivery (reducing required eluate volumes to < 1 μL). Results will be compared with allergen results obtained by traditional immunoassays of dust and air samples collected contemporaneously.

2) Enhanced polydimethylsiloxane (PDMS) microfluidics will be incorporated onto a larger Array F2 array, allowing multiplexed microfluidic access to each array site. Fluorescence resonance energy transfer (FRET) will be explored for real-time measurement of antigen binding, exploiting the fluorescence lifetime measurement capabilities of the active arrays.

3) Develop integrated CMOS piezoelectric array sensor, exploiting the packaging and microfluidics of the fluorescence chips, to perform real-time mass-based measurement.