Guest editorial

# Cockroach allergen abatement in inner-city homes

Ever since the papers from the National Cooperative Inner City Asthma Study (NCICAS) demonstrated how common cockroach allergen is in inner-city homes and how strongly sensitization and asthma morbidity are related to exposure,[1–3] investigators have discussed methods to reduce exposure. It was obvious that the first challenge would be eliminating the source (cockroach) in crowded urban apartments and other housing. The next problem would be removal of the allergens. The article by McConnell et al[4] in this issue of the *Annals* illustrates how difficult these challenges will be.

First, the study tells us that it is difficult to eliminate the allergen source. Pest control experts[5] think of controlling pest populations rather than exterminating them, because they believe that it is not realistic to eliminate all cockroaches. The currently accepted approach is called integrated pest management or IPM and combines pesticide application with family education and structural elimination of hiding places ("harborages"). Recently, toxicologists have raised issues about the safety of the application of pesticides in homes, especially at the high doses required to reduce cockroach populations. The pesticide used by McConnell et al, fipronil, is a newer agent that is both effective and safe. It is available as a gel bait, licensed to pest control companies, and provided in lower concentrations in bait traps sold to the consumer in grocery and hardware stores. The gel baits described in the article are odorless and colorless and are placed by the pest control technician in blobs smaller than a dime in multiple areas in a room. Because they are unobtrusive and harden quickly, these agents are not generally attractive to pets and children. Other newer pesticides, including hydramethylnon, sulfluramid, and abamectin, are also available in gel baits and are both more effective and safer than older agents, such as organophosphates and boric acid. Boric acid is safe but is much less effective than any of the newer agents. In heavily infested homes such as the ones included in this study, a second or third application is required because the roaches consume the bait. Family expectations need to be addressed, since these new agents are somewhat slow to act, taking several weeks to have maximum effect.

Of the older agents, the class that raised most safety concerns was the organophosphates, which were effective but had acute neurologic toxicity in large doses and were thought to have long-term neurologic and developmental toxic effects in humans as well.[6,7] In 2000 the Environmental Protection Agency removed its certification for indoor use of chlorpyrifos, one of the organophosphates, because of this issue.[8] Other older pesticides, including pyrethrin and synthetic pyrethrins such as deltamethrin and fenvalerate, are also effective. Because they have a characteristic pungent odor that is less acceptable to consumers and because there are emerging questions concerning chronic toxicity,[9] these pesticides are less used than previously. Abamectin is one of the safest new pesticides. It has a substantial history of oral use in animals and humans as an antihelminthic[10] and as an oral treatment for scabies.[11]

In the article by McConnell et al, cockroach extermination was partially effective. Using professional pest control technicians, an effective pesticide (fipronil gel baits), and 2 treatments, they were able to eliminate cockroaches in 25% of the actively treated homes as judged by passive "sticky" traps, and the median cockroach count was reduced by approximately 90%, from 136 to 14 insects. Although this seems encouraging, it compares with a recent article by Arbes and colleagues,[12] in which more than 50% of homes had no cockroaches recovered in sticky traps at follow-up, and to our own studies,[13,14] in which cockroaches were eliminated in 62% to 64% of homes in active treatment groups. Why were they less successful? The most apparent answer is that the study was short, 10 weeks from the first extermination and 3 weeks from the second. The new agents act through a combination of direct toxicity and interference with reproduction, so they generally take 1 to 2 months to be optimally effective.[5] In addition, heavily infested homes require an initial cleaning of food debris so that the insects will eat the baits and a second bait application within a week to replace baits that have been cleaned out by hungry cockroach populations. All of these factors might have contributed to a somewhat less effective extermination. At the same time, I would agree with the authors' conclusion that the study demonstrates that short-term professional insecticide application reduces the number of cockroaches and eliminates cockroaches in some homes; the glass is half full.

Since the allergen source was partially controlled, it is not surprising that allergen levels showed only a partial reduction. In earlier studies[12–14] with more complete roach control and longer follow-up, residual cockroach allergen proved even more difficult to remove from homes than animal dander. Cat allergen takes 6 months of household cleaning to remove from a home once the cat is removed,[15] whereas in the same period, cockroach allergen had been reduced by

70% to 80%. The most likely explanation for this difficulty is that particles carrying either cockroach or cat allergen are adherent and contaminate so much of the home that a home allergen reservoir exists that is large and complex and requires months of cleaning to remove. We would agree with Arbes and colleagues that the ecology of cockroach also contributes to this difficulty.[12] Roaches seek hiding places where both their backs and bellies are touching a hard surface; so they tend to cluster in narrow crevices where allergen-laden carcasses are difficult to remove. In addition, roaches regurgitate digestive fluids containing Bla g 1 and Bla g 2 while feeding, leaving a residual that may be visible as a brownish stain resembling cooking grease. For all these reasons, it is not surprising that it may take more than 6 months of cleaning to remove the last traces of allergen contamination.

Another important finding with regard to exposure to cockroach allergen is that bedding is heavily contaminated. In the article by Arbes et al, dust samples from the bed and the bedroom floor were assayed independently and bedding contained an average of approximately 6.1 U/g of Bla g 1. They proposed that bedding had become contaminated passively, carried into the bed on feet and clothing. This was our experience in a trial of reducing allergen in bedding by treating the home and providing clean bedding every 2 weeks.[16] We found allergen in occupant's clothing and found that bedding became contaminated within days of placement. Passive distribution also seemed to be the best explanation for our finding that middle-class homes, in which infestation had never occurred, contained low levels of allergen in kitchens, presumably tracked in on shoes and paper products.[17] Bedding contamination is important, since cockroach allergen is carried on large particles that do not remain airborne under usual circumstances.[18] Thus, exposure to cockroach allergen is likely to be through intimate contact with bedding while sleeping, just as in the case of house dust mite.

The authors question whether the reductions that they were able to achieve would have an effect on symptoms on morbidity in allergic asthmatic residents. Although there are no trials of cockroach allergen avoidance yet reported with health outcomes, it is possible that significant health improvement would be seen. House dust mite allergen exposure is a good example of an allergen in which exposure occurs primarily in bedding and in which successful bedding treatment leads to long-term improvement in allergic asthma. In reported house dust mite intervention trials, those that focused on bedding and were able to achieve a 50% reduction in bedding allergen levels generally showed significant reduction in morbidity (symptoms, peak flow rates, medication use) in mite-allergic asthmatic patients.[19] There does not seem to be a safe threshold, and as long as this proportional decrease is achieved, significant improvement in allergic asthma is seen, regardless of the starting level of allergen.

The NCICAS intervention trial mentioned in the article was a global intervention, with only modest attention to a cockroach allergen intervention. The global intervention was effective and reduced asthma morbidity, but cockroach allergen did not decrease, so cockroach allergen abatement could not be said to have contributed.[20] There are now at least 3 clinical trials ongoing that are testing the clinical effects of cockroach allergen reduction on asthma severity. The Inner City Asthma Study is a National Institute of Allergy and Infectious Diseases–sponsored multicenter trial that has enrolled more than 300 asthmatic children. In preliminary results presented at the American Academy of Allergy, Asthma and Immunology annual meeting, the study investigators reported significant clinical results with a lesser reduction in cockroach allergen. Other clinical trials are ongoing and results are not available, but these early results appear promising that cockroach allergen abatement will have a significant health effect on asthmatic patients living in US inner cities.

The article by McConnell et al raises the issue of costs of this therapy and questions whether this will limit the widespread use of environmental avoidance. Their study represents what is technically called an *efficacy* trial in that the investigators chose to apply the treatment with as little reliance on the adherence of the participating families as possible. This is as opposed to an *effectiveness* trial, which would apply the treatment as it might be applied in clinical practice or by a public health department, usually relying on participant adherence. Recently, the first large effectiveness trial of house dust mite allergen avoidance was reported[21] and was disappointing to those of us who believe that modifying the allergic component of asthma is a sensible approach to treatment. Cockroach allergen exposure relates to an entirely different allergen source, one that may be modified by addressing housing maintenance and may be more amenable to treatment by public health agencies. We should be encouraged by these successful, early efforts to develop an asthma intervention that is appropriate for public health agencies and does not rely on long-term drug treatment.

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