

Short communication

Wipe test for the detection of indoor allergens

Background: The determination of house dust mite and cat allergens is a prerequisite for qualified assessment of exposure risk indoors. We describe the validation of integrated wipe tests comprising a porous sampling pin for the collection of settled house dust and an immunochemical test set-up for specific analysis of dust associated allergens.

Methods: Wipe tests comprised an immunochromatographic test system and a porous sampling pin for collecting dust by manually wiping a surface. Two different wipe tests were developed with specificity to cat allergen (Fel d 1) and to dust mite allergen (Der p 2/f 2). One-hundred and fifty on-site determinations for each of the allergens in 50 different households completed the field study to validate the analytical system. Reference analysis was based on collection of dust with a vacuum cleaner and analysis of dust associated allergens by ELISA.

Results: The wipe tests were found to produce semiquantitative results (class 0–3) on-site within 10 min of analysis time. For dust mite (cat) allergen the median of class 0–3 was 119 (263), 812 (844), 2708 (5670) and 8000 (56 800) ng/g dust, respectively. With respect to cut-off levels for dust mite (cat) allergens the clinical sensitivity was 62% (79%) and the clinical specificity was 94% (92%).

Conclusions: The wipe tests proved to be a reliable tool for indoor allergen exposure screening, suitable for use even by untrained persons. This may have an impact on compliance with allergen avoidance measures.

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Due to the fact that people in industrialised countries spend more than 90% of their time indoors, exposure to indoor allergens, particularly to the allergens of house dust mites and cats, is a significant causal factor with regard to the development of allergic asthma, atopic eczema/dermatitis syndrome and allergic rhinitis (1–5). A number of studies have indicated that a reduction in allergen exposure improves the clinical symptoms in individuals suffering from allergic disorders (2, 4, 6, 7).

Immunochemical methods of determining indoor allergens are time-consuming and require substantial scientific expertise. Recently, Tsay et al. established a rapid and semiquantitative assay for the detection of dust mite allergens in samples of house dust (8). Nevertheless, the collection, definition and extraction of dust samples still take the form of separate steps that have to be performed prior to analysis.

We have developed a new integrated analytical system that allows easy collection and analysis of dust-associated indoor allergens. The wipe tests comprise a self-contained immunochemical test and a microporous sampling pin, both housed in a plastic cassette (Fig. 1). Wipe tests for the specific detection of cat allergens (Fel d 1) and mite allergens (Der p 2/f 2) were prepared (9). Validation data are presented in this paper.

Material and methods

Homes and use of the wipe tests

Between March 1999 and June 1999, a field test was performed in 50 different homes of nonallergic people in Lübeck, Northern Germany. At each location, e.g. mattresses, carpets and upholstery, two wipe tests of each type were conducted, one by the volunteer and one by the supervisor.

House dust was collected in the pores of the sampling pin by manually wiping the pin over a surface area of 0.1 m² for 60 s. Subsequently, five drops (150 µl) of extraction buffer (0.1 M phosphate buffer + 0.4% Tween 20) were applied to the sampling pin to extract the allergens and to start the autonomous immunoanalytical process. After 10 min of reaction time, the results which appeared in the window of the plastic cassette were visually assessed.

House dust collection and analysis of allergens

Reference dust samples were collected by a trained technician using a vacuum cleaner (1200 W) and a dust collector (Mitest, Dublin, Ireland). The same spots analyzed by the wipe tests were vacuumed for 2 min. An amount of 50 mg of dust was suspended in 2 ml of dilution buffer (0.01 M phosphate buffer + 0.4% Tween 20 + 1% bovine serum albumin). Dust extracts were analyzed for the presence of cat (Fel d 1) and mite (Der p 2/f 2) allergens using enzyme-linked immunosorbent assays (Indoor Biotechnologies, Charlottesville, VA, USA).

Statistical analysis

The different parameters did not approach a normal distribution, even after log transformation. Results were expressed as median, 1st–

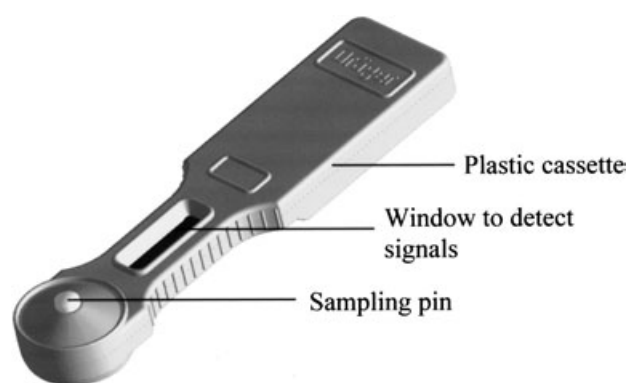


Figure 1. Schematic view of the wipe test device.

3rd quartiles. The nonparametric Mann-Whitney *U*-test was used to compare the different classes of test results. Statistical analysis was performed with SPSS for Windows.

Results

One-hundred and fifty-one textile surfaces were assayed for dust mite allergens and 148 loci for cat allergens. In total, 600 wipe tests were performed on site, of which only two tests failed due to the hydrophobicity of the dust loaded sampling pin and as a result of flow problems in the analytical device.

The semiquantitative test graded the colour/allergen content on a four-point scale: class 0: no allergen detectable; class 1: low allergen content; class 2: high allergen content; class 3: very high allergen content. For dust mite (cat) allergen the geometric mean was 119 (263) ng/g for class 0, 812 (844) ng/g for class 1, 2708 (5670) ng/g for class 2 and 8000 (56800) ng/g for class 3 (Table 1). Although the range of values indicated by the 1st to 3rd quartiles was quite wide, the difference between each class reached statistical significance ($P < 0.05$).

Because every spot was sampled twice, once by the volunteer and once by the supervisor, the interindividual precision could be derived from the wipe test results: 80% of the wipe test duplicates were in the same class, while in 18% of the duplicates a deviation of one class and in 2% of the duplicates a deviation of two classes was noted. This degree of precision has to be estimated as reasonably high, taking into account that

house dust is a heterogeneous matrix and that dust sampling depends on the individual wiping mode of the user.

In order to achieve clinical utility of a diagnostic test and to calculate clinical sensitivity and specificity, a cut-off concentration needs to be set above which dust samples are classified as positive. We used a concentration of 2000 ng/g for dust mite allergen and 8000 ng/g for cat allergen as cut-off levels which are regarded as risk levels for sensitization (1). However, cut-off levels for sensitization are difficult to establish and it is evident that sensitization in some individuals may occur at lower levels. If classes 2 and 3 are grouped and regarded as positive results, and cut-off levels for dust mite and cat allergens are used as the basis, the clinical sensitivity and specificity of the dust mite allergen test (cat allergen wipe test) were 62% (79%) and 94% (92%), respectively. For those applications requiring a lower false negative rate, clinical sensitivity can be increased by regarding classes 1, 2 and 3 as positive results.

Discussion

It was postulated by different parties that easy to use and cost-effective specific screening tools are needed for control of allergen exposure indoors (2, 4, 10). Rapid tests, which can be used on site, are capable to overcome the high labour costs of microtitre plate-based allergen-immunoassays. The well-established guanine assay has been shown to correlate reasonably well with the dust mite allergen content of reservoir dust (10). However, the guanine assay is restricted to the detection of house dust mites and is suffering from a multistep handling procedure. Recently, a rapid and semiquantitative immunoassay for the detection of dust mite allergens (Der p 2/f 2) has been developed showing correlation with reference analytics (8, 11). This assay was designed to be used on site, but collection (by use of a vacuum cleaner), extraction and analysis of dust samples still take the form of separate steps.

The presented wipe tests provide a sensitive and selective method of determining exposure to indoor allergens in settled house dust on-site. The integration of dust sampling and a self-contained analytical system makes this a convenient exposure screening test which

Table 1. Allergen levels in house dust within the four different wipe test classes

	Wipe test results for allergen class			
	0	1	2	3
Mite allergen (Der p 2/f 2)				
Geometric mean (ng/g)	119 (<i>n</i> = 110)	812 (<i>n</i> = 124)	2710 (<i>n</i> = 24)	8000 (<i>n</i> = 44)
1st–3rd quartile	101–523	199–1874	1582–3918	4265–18 553
Cat allergen (Fel d 1)				
Geometric mean (ng/g)	263 (<i>n</i> = 148)	844 (<i>n</i> = 84)	5670 (<i>n</i> = 30)	56 800 (<i>n</i> = 34)
1st–3rd quartile	90–685	192–3699	3564–29 376	20 114–158 534

allergists, other practitioners and allergy-sufferers themselves can easily conduct in the domestic environment both before and after intervention measures. This may have an impact on compliance with allergen avoidance and prevention measures.

In addition to the detection of other indoor allergens, e.g. from dogs, cockroaches and moulds, this new wipe test platform has the potential to be applied to other medical areas, e.g. sweat and saliva testing or diagnosis of dermal surfaces.

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