



REVIEW

New insights in allergen avoidance measures for mite and pet sensitized patients. A critical appraisal

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Summary It is widely acknowledged that avoidance of allergens such as those derived from foods, drugs, latex and stinging insects results in a complete disappearance of symptoms. By contrast, although it has been clearly shown that allergens are an important risk factor for the development of respiratory symptoms and that several avoidance measures reduce allergen levels, whether this gives clinical improvement in symptoms is debatable.

Many reasons could be invoked to justify this evident discrepancy. Apart from the intrinsic methodological aspects (e.g. single or combined interventions measure, population studied, severity of respiratory symptoms, outcomes, evaluated parameters, etc.), it is important to outline that a successful approach requires that the avoided allergen is the only and real factor responsible for symptoms, the patient's education and the use of a comprehensive protocol to reduce allergen exposure. Other important factors include the involvement of the patient, the relevance of other allergens/non-specific agents, and exposure to sensitizing agents also outside patient's home.

It is likely that the clinical phase of allergic airway disease and the degree of bronchial (and also nasal) remodelling, in each individual, represent relevant factors for the clinical outcome of allergen avoidance procedures. Since the management of respiratory allergy is a complex strategy (including drugs, allergen avoidance, immunological and educational interventions), it is difficult in real life to distinguish the efficacy of a single intervention in comparison to the others. A combined strategy is likely to produce better clinical results.

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Introduction

It is now quite clear that the development of respiratory allergies depends on a complex interaction between genetic, maternal and environmental factors. Among the latter ones, exposure to allergens, endotoxins, indoor and outdoor air pollution seem to be the more relevant. It is also likely that changes induced by human activities in indoor and outdoor environments, as well as the “Westernized” lifestyle, play an important role in increasing the prevalence of atopic diseases in the general population.¹ On the other hand, it is generally accepted, with some exceptions^{2,3} that atopy is a main risk factor for the development of bronchial asthma, especially in children.⁴

Certainly, the characteristics of modern indoor environments (insulation of doors/windows, reduced natural ventilation, upholstered furniture, central heating, etc.), at least in Western countries, in addition to the current lifestyle (more time spent indoors) increase the duration and intensity of exposure to mites, pets and cockroach products^{5,6} as well as to indoor chemical agents. In this regard, it has been clearly shown that exposure of sensitized patients to allergens is a risk factor for development of asthma and asthma exacerbations.^{7,8}

A direct correlation between the exposure to dust mite allergens and the development of allergic sensitization is generally easy to demonstrate,

especially in children, whereas in adults or in previously sensitized subjects the relationship is less clear, since asthma symptoms in each individual may be induced by different doses of allergen and even by non-specific agents.⁹ It is indeed ascertained that atopic asthma is more severe in sensitized patients, when they are exposed to high levels of allergens.^{10–13} Different studies have also suggested that the effect of the environment on airways starts early. For instance, it has been shown that maternal smoking in pregnancy has a significant impact on lung function in newborn.¹⁴ Similarly, allergen exposure during early pregnancy was shown to affect the cellular proliferative responses during late pregnancy.¹⁵

All the aforementioned observations, taken together, indicate that preventive or avoidance measures (possibly taken already during pregnancy) should be crucial. Allergen avoidance is highly effective in selected conditions such as drug allergy, hymenoptera venom hypersensitivity, food and latex allergy. On the contrary, although experimental data generally support the efficacy of allergen avoidance strategies in respiratory allergy, their real outcome is still controversial¹⁶ (Fig. 1).

This review will focus on recent advances in mite and pet allergen avoidance strategies, starting from the last months of pregnancy onwards. A particular attention will be paid to the outcome measures used, as well as to the objective evaluation of cost/benefit ratio of these procedures.

Models for assessing the effects of aeroallergen avoidance

Occupational asthma represents a very simple model to verify the relationship between allergen exposure and respiratory symptoms, as well as the outcome of allergen withdrawal. In the majority of studies it was clearly shown that workers completely recovered or significantly improved when removed from their working environment.^{17–21}

Avoidance trials performed at high altitudes, where mites do not survive, provided important lessons on the effectiveness of avoidance procedures. Studies carried out in Misurina, Italy, and in Davos, Switzerland (more than 1500 m over the sea level), confirmed the effects of a virtually mite-free environment on clinical and laboratory indexes in asthmatic children sensitized to mite allergens (Table 1). Indeed, the observed clinical improvements in those conditions could be also attributed to the absence of other pro-inflammatory agents such as air pollutants. The fact that children relapsed after returning to sea level does not help discriminating the real quantitative effect of allergen avoidance.

The models of occupational allergy and mite-free environments seem to support the effectiveness of

avoidance procedures, at least in particular conditions. Nevertheless, in the last few years conflicting opinions have come out. In 1998, the Cochrane Collaboration published a meta-analysis of secondary mite allergen avoidance. The reviewers concluded that “current physical and chemical methods aimed at reducing exposure to allergens from house dust mites seem to be ineffective and cannot be recommended as prophylactic treatment for asthma patients sensitive to mites”.^{34,35} On the contrary, Platts-Mills et al. pointed out that “the real question posed by prevention strategies is not whether allergen avoidance is good for allergic patients with asthma but whether the changes that have been consistently demonstrated in a sanatorium, hospital room or at high altitude can be achieved in real homes”.³⁶

In this regard, a comparison among the different studies of avoidance intervention in asthmatic patients is virtually impossible to perform, due to the large number of variables involved. Some of these variables among studies include: heterogeneity of disease's severity, confounding drug treatments, multiple sensitization, concomitant use of multiple avoidance procedures, considered outcomes, allergen sampling methods and duration of the studies.¹⁶

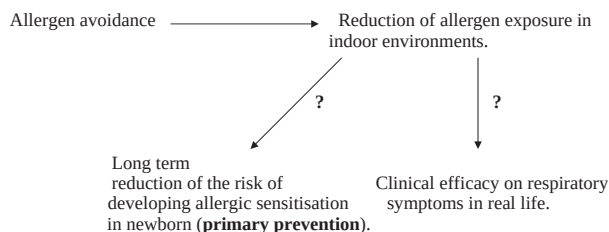


Figure 1 Relationship between allergen avoidance procedures, allergen exposure and clinical outcomes.

The “threshold level” for mite and pet allergens

Different levels of mite and pet allergens inducing sensitization and/or asthma exacerbations have been suggested.³⁷ However, these threshold amounts of allergen may greatly vary, according to the individual degree of bronchial responsiveness and the possible effect of non-specific

Table 1 Observed effects on clinical and laboratory parameters in mite sensitised children at high altitude.

Author	Year	References	Outcomes
Boner et al.	1985	22	Exercise-induced bronchial reactivity, medication intake
Boner et al.	1993	23	Serum markers of eosinophil activation
Van Velzen et al.	1996	24	Non-specific bronchial hyperreactivity (BHR)
Peroni et al.	1994	25	Non-specific and specific BHR, total and specific IgE
Piacentini et al.	1993	26	Antigen-provoked basophil histamine release and specific IgE
Piacentini et al.	1996	27	Sputum eosinophilia
Piacentini et al.	1998	28	Bronchial epithelial shedding
Simon et al.	1994	29	T helper cell activation
Piacentini et al.	1999	30	Exhaled nitric oxide
Peroni et al.	2001	31	Residual volume and sputum eosinophils
Grootendorst et al.	2001	32	Quality of life, BHR, urinary eosinophil protein X and leukotriene E
Peroni et al.	2002	33	Residual volume and exhaled nitric oxide

irritants.⁹ Given the variable susceptibility of sensitized patients and the variability over time of allergen exposure, it is difficult to calculate a fixed and standard environmental concentration of allergen (possibly expressed as $\mu\text{g/g}$ of dust or $\mu\text{g/m}^2$), as a threshold valid for all individuals.^{38,39} Previous trials have demonstrated that a concentration of $2\mu\text{g Der p 1/g}$ dust is the threshold for inducing sensitization, whereas $10\mu\text{g/g}$ represents the threshold for triggering asthma attacks in mite allergic individuals.⁴⁰ Based on these results it was argued that an exposure constantly below $2\mu\text{g/g}$ of dust would have provided measurable clinical results.⁴¹ Nevertheless, other authors have suggested that the threshold concentration of Der p 1 inducing airway sensitization is inferior, because highly susceptible children may become sensitized at concentrations 10–100 times lower than $2\mu\text{g/g}$.^{42,43} In patients sensitized to cat, the threshold concentration of Fel d 1 inducing sensitization and triggering bronchial obstruction is lower: 1 and $8\mu\text{g/g}$ of dust, respectively.⁴⁴ Also in this latter case there are conflicting opinions. The amount of cat allergens in the dust may not reflect the real global environmental exposure, since Fel d 1 is largely present also as airborne particles and not only in the dust. Probably, the threshold level should be better determined by airborne samplers.⁴⁵

Mite and pet allergen carrying particles

The determination of sources and aerodynamic characteristics of allergen carrying particles is an important tool for designing mite and pet allergen avoidance strategies.⁴⁶ Group 1/group 2 mite allergens are carried by relatively large particles ($>10\mu\text{m}$ diameter), which can be detected in the air of indoor environments only after a strong disturbance, whereas in quiet conditions, these allergens can be found only in reservoirs.⁴⁷ On the contrary, allergens derived from domestic animals such as cat (Fel d 1) and dog (Can f 1) are carried both by large particles of about $10\mu\text{m}$ diameter (75%) and by smaller particles of $<5\mu\text{m}$ diameter (approximately 25%).^{48,49} After a minimal air disturbance, these small particles readily become airborne and so remain for long periods. The airborne dispersed allergens can trigger respiratory symptoms in sensitized patients within few minutes. This is the reason why air filtration devices may be useful to reduce the amount of pet allergens in the air⁴⁷ by approximately two- to four-fold.⁵⁰ Of course, these devices are not effective in removing allergens from their reservoirs.

Aeroallergen avoidance during pregnancy and early life (primary prevention)

In the last few years an increasing interest has been devoted to the perinatal period and early infancy as critical time intervals for the subsequent development of respiratory allergy. This has envisaged the possible role of reducing exposure to aeroallergens in these periods to prevent the development of allergic sensitization and bronchial asthma. Indeed, apart from the exposure to tobacco smoke, the scientific evidence for the effects of environmental factors on the development of allergic sensitization and asthma is still controversial.⁵¹ Effective primary preventive methods have been difficult to assess, and those currently suggested are questionable.⁵²

The optimal approach to study the effects of primary prevention should be a randomized intervention study, starting in pregnancy and involving many high-risk families. This type of study is complex, time-consuming and expensive, but crucial to establish the efficacy of such approach to reduce the prevalence of respiratory allergies. In the last few years, several birth cohort studies of inhalant allergens avoidance (also associated to food allergens avoidance) have been performed. As summarized in Table 2, environmental interventions were generally able to significantly reduce the allergen load (especially those of dust mites). On the contrary, although preliminary results are encouraging, no final conclusion on the clinical effect of allergen avoidance in reducing the risk of developing respiratory allergy can be drawn. It is not known how long these intervention measures should be continued, and how long the children should be followed up, but it is likely that a very long time would be necessary to obtain incontrovertible answers.

The environmental interventions to reduce the levels of indoor allergens, especially those produced by mites and pets, used in the primary prevention studies are the same that were recommended in secondary and tertiary prevention (see after). It is important to outline the role of the compliance of the parents receiving advice to reduce exposure to mite and pet allergens and to avoid passive smoking.^{60,66}

The problem of bedding materials

Beds are the most important source of mite allergens. Dust mites can find a large amount of food in terms of human epithelial derivatives and thus they optimally proliferate in beds. In addition, sleeping patients are exposed to mite allergens for

Table 2 Environmental allergen control and/or clinical outcomes in primary prevention studies.

Author	Year	References	Intervention	Reduction of allergen amount	Clinical efficacy
Arshad et al.	1992	53	Dietary+Environmental	+	+
Hide et al.	1996	54	Dietary+Environmental	+	+
Arshad et al.	1993	55	Dietary+Environmental	+	+
Mihrshahi et al.	2003	56	Dietary+Environmental	+	+/-
Chan-Yeung et al.	2000	57	Dietary+Environmental	+	+
Halmerbauer et al.	2004	58	Dietary+Environmental	NA	+
Backer et al.	2004	59	Dietary+Environmental	+	+
Schonberger et al.	2004	60	Dietary+Environmental	+	NA
Custovic et al.	2000	61	Environmental	+	NA
Custovic et al.	2001	62	Environmental	+	+
Simpson et al.	2003	63	Environmental	+	NA
Koopman et al.	2002	64	Environmental	+	+/-
Wickman et al.	2003	51	Environmental	+	+
Mihrshahi et al.	2003	65	Environmental	+	NA

NA = not applicable.

hours. Based on this background, the reduction of mite allergen exposure in the bedroom and bed is generally considered a primary target for avoidance measures.

New mattresses

In clinical practice, it is often suggested to buy a new mattress for newborn babies. This recommendation relies on the assumption that new mattresses are free of allergen. A recent study by de Boer et al.⁶⁷ performed on newly bought mattresses demonstrated that only 15 of the 90 mattresses contained no detectable amount of the four tested allergens (Der p 1, Der f 1, Fel d 1 and Can f 1). The study showed that also new mattresses, wrapped in plastic, may contain a substantial amount of allergens, and does not substantiate the clinical-based recommendation for newborns. A regular vacuuming of the new mattresses is also suggested to ensure the removal of mite allergens. However, this type of treatment (at variance with the use of chemical agents) is very difficult to perform because the thickness of the mattresses does not allow an effective intervention. Also, new mattresses are rapidly infested by dust mites under favourable climate and housing conditions such as dampness.^{68,69}

Encasings and impermeable covers

It is usually accepted that the most effective avoidance measure is the use of mite-impermeable covers for the mattresses, pillows and duvets⁷⁰ in

association with washing bedding materials at hot temperature.⁷¹ These procedures are commonly used in clinical practice. Nevertheless, looking at the literature, there are conflicting results on the efficacy of physical barriers. Many reasons can be addressed to explain these differences (combined use of other anti-mite procedures, study design, study population and outcomes). Also, the type of material used for encasing (plastic sheet, polyurethane, non-woven tissues, microfibre covers) represents an important variable. In this regard, Mahakittikun et al.⁷² performed a detailed laboratory assessment (heat escape method, Siriraj chamber method, stereomicroscopy, scanning electron microscopy and enzyme-linked immunosorbent assay) to establish the efficiency of encasing materials against house dust mites and their allergens. Only encasings with a pore size of 2–10 µm (mean 6 µm), such as tightly woven microfibre covers, could completely prevent the passage of mites and mite-derived materials still retaining a good level of comfort and air permeability.⁷³

However, from a practical point of view, it is important to clearly distinguish between the two efficacy outcomes in real life.⁷⁴ The effects of physical barriers on allergen amount (allergen content, number of mites, proliferation, etc) are easy to verify and quantify with laboratory techniques, but the clinical effects (symptoms) often do not reflect what is observed under controlled conditions.⁷⁴ As shown in Table 3, encasings are clearly able to reduce the amount of mite allergens. However, the use of anti-allergic mattress covers, as a single intervention measure, does not result in significant clinical benefit in adult asthma.

Table 3 recent studies (1999–2004) on the effects of encasings in respiratory allergy (tertiary prevention).

Author	Year	References	Reduction of allergen amount	Clinical efficacy
Cloosterman et al.	1999	75	+	—
Rijssenbeek et al.	2002	76	+	—
Sheikh et al.	2003	77	NA	—
Koopman et al.	2002	64	+	—
Rijssenbeek et al.	2002	78	+	+ Nasal — Bronchial
Arshad et al.	2002	79	NA	+
Halken et al.	2003	80	+	+ Reduced inhaled steroids
Brunekreef et al.	2002	81	+	—
Woodcock et al.	2003	82	+	—
Terrehorst et al.	2003	83	+	— Nasal
Luczynska et al.	2003	84	+	—

Some previous ^{30,43,85} and a recent ^{86,87} meta-analyses have confirmed that bedding encasement might be an effective avoidance procedure in some patients with asthma, but data from clinical trials suggested that the clinical effect is marginal.

Synthetic and feather pillows/mattresses

Feathers in pillows and bedding have long been considered as an ideal breeding ground for dust mites and, consequently, a potential source of mite allergen exposure. Moreover, feather itself has been previously considered as an allergen. Therefore, it has become common to advise allergic peoples to avoid the use of feather bedding, but the evidence for such recommendation is not strong.^{88–90} In this regard, recent studies have demonstrated that feathers are not allergenic, and the positive skin prick test responses are likely due to mite contamination.^{91,92} Moreover, modern feather bedding manufacturing procedure involve washing and hot drying that are able to kill mites and to denature group 1 mite allergens.⁹³

Recent cross-sectional studies have shown that synthetic bedding is significantly associated with several respiratory diseases. Synthetic pillows contain higher concentrations of several types of allergens (mite and pets) compared with feather pillows.^{94–96} Moreover, the risk of finding mite faeces was found four-fold higher in foam compared to spring mattresses and eight times higher for the foam mattresses without cover.⁹⁷ Besides the finding that synthetic materials contain higher amounts of different indoor allergens, some hypotheses have been suggested to explain the association between synthetic bedding and development of respiratory allergy: release of organic

volatile compounds, intrinsic allergenicity of the materials, the covers of feather pillows are more impermeable to mite allergens (tightly woven microfiber covers), etc.⁹⁸ In the light of these controversial findings, there is a weak scientific basis for recommending non-feather or synthetic bedding in our mite sensitized patients or in infants of highly atopic parents. Further longitudinal (randomized and controlled) studies are required for a conclusive assessment of this question.^{89,90}

Washing and drying systems

All bedding and covers should be washed at a temperature of at least 55 °C that is ideal to kill mites. However, higher temperatures (120–140 °C) are required to denature Der p 1 and Der p 2, as well as the group 1 and 2 allergens of *Dermatophagoides farinae*.⁹⁹

Commercial, and likely also domestic, hot-laundering results in near-complete removal of mite allergen from bedding. However, a wash cycle where temperatures above 55 °C are sustained for at least 12 min (or above 60 °C for 8 min) is sufficient to eliminate >80% of mites.¹⁰⁰ Considerable variation exists in the ability of both domestic and commercial machines to reach such temperatures, and this ability should be confirmed before recommending hot-laundering as a method of eliminating house dust mites from textiles.¹⁰⁰

Exclusive washing in cool water may remove mite allergens, but does not kill mites. It has also been demonstrated that live mites can be transferred from mite-infested to mite-free items during washing.¹⁰¹

The association of soluble form of benzyl benzoate (0.03%) or some essential oils (e.g.

eucalyptus oil) may achieve a greater acaricidal activity.^{71,99,102} Recent studies have shown that washing clothing and bedding with detergents or detergents plus bleach in cold or warm water are able to remove most (98%) mite and cat allergens, but repeated washing is required to further reduce mite levels. Dry cleaning may also be useful either to kill mites or to remove allergens from blankets, although it is less effective than washing in hot water.^{101,103,104}

Interventions on environmental air

Control of humidity

The control of indoor humidity (<45%), is an important measure to reduce mite growth. However, evidence that a reduction in indoor humidity induces a concomitant reduction in humidity in mite microhabitats is still lacking.⁴⁷ An increased natural ventilation rate may be useful in those geographic areas in which the outdoor air is sufficiently dry. Some studies have suggested that dehumidifiers in the basement and air conditioners may play an important role in controlling mite growth in temperate climate. Nevertheless, the outcomes of such measure are marginal, and their clinical efficacy is too controversial to make recommendations.^{105,106}

Air filtering

The idea of filtering the air we breathe in order to remove allergens is theoretically attractive. However, several technical problems still exist especially concerning the filters used. The main requirements for an optimal air filtering system are: low resistance to airflow, cleaning efficiency, low or no need for maintenance interventions and long life. The most efficient filters are HEPA filters. These are defined by their filtration efficiency

(99.97% of all airborne particles of 0.3 µm are removed from the air passing through them).

Although both allergic and non-allergic individuals may achieve symptomatic benefit from removing irritant particles such as tobacco smoke from the air, filtration units do not reduce the levels of mite allergens in indoor environments. In fact, the greatest amount of these allergens remains in settled dust. On the contrary, a long-term use of HEPA-equipped air cleaners may be useful to remove large amounts of airborne particles carrying cat and dog allergens. Also in this case, conflicting opinions still exist on the clinical efficacy of air filtration units, also considering their high cost (Table 4).

Chemical agents

Over the last 30 years, a variety of chemicals has been tested for their ability to kill mites in culture (Table 5). It is important to outline that mites are not insects and that many excellent insecticides do not kill mites at the concentration that can be used in houses. Although many agents demonstrate an optimal in vitro activity, their efficacy in real life depends upon other factors such as method and time of application, type of formulation (liquid, moist powder, foam, spray, etc), local conditions (e.g. type and thickness of carpets) and effectiveness of vacuum cleaning in removing dead mites and their products from reservoirs after their use.

The results of clinical studies of these products are controversial. In fact, some authors demonstrated positive benefits in controlling mite populations and, consequently, clinical symptoms in allergic patients,^{114,115} but other studies failed to confirm these positive effects.^{116,117}

Most studies of acaricides or allergen-denaturing agents suggest that repeated applications (every 2–3 months) are needed to prevent mite re-infestation. The need for a long-term use of these

Table 4 Effects of air cleaners in mite and pet allergy.

Author	Year	Reference	Mite allergen removal	Pet allergen removal	Clinical results
Van der Heide et al.	1997	107	—	+	—
Green et al.	1999	108	NA	+	NA
Warburton et al.	1994	109	NA	NA	—
Van der Heide et al.	1999	110	NA	+	+
Wood et al.	1998	50	NA	+	—
Gore et al.	2003	111	NA	+	+ / —
Francis et al.	2003	112	NA	—	+ / —

NA = not applicable.

agents rises the problem of their potential toxicity especially to children or domestic animals.

Very few studies have evaluated the role of chemical agents in reducing the degree of exposure to pet allergens. Recently, Matsui et al.¹¹⁸ demonstrated that low concentrations of sodium hypochlorite (NaOCl), the active ingredient in household bleach, modifies rFel d 1 resulting in loss of immunogenicity and attenuation of biologic activity, as measured by its ability to stimulate basophil histamine release.

Vacuum cleaners

Regular and intensive vacuum cleaning is considered useful to reduce the amount of mite (or pet) allergens in the reservoir, but the simultaneous use of other measures is mandatory for effective elimination of allergens in carpets and furnishings.¹¹⁹

The major problem with vacuum cleaners is that, independent of the potency of the apparatus, they cannot completely remove live mites from surfaces (e.g. carpets) and they even allow debris to accumulate. There are two critical aspects in carpet cleaning: first, whether the cleaner can remove dust from the carpet and, second, how much allergen/dust becomes airborne while the cleaner is in use.

The new exhaust filtration systems, e.g. HEPA filters and double-thickness bags, electrostatic filtration system,¹²⁰ or polyethylene filters that can be easily washed in water¹²¹ seem to be efficient enough to avoid an increase in the indoor airborne levels of mite allergens.

Gore et al.¹²² demonstrated a three- to five-fold increase in personal cat allergen exposure while using both high-efficiency new vacuum cleaners

and older vacuum cleaners including a water-activated device. The evaluation of personal exposure to allergen was carried out using nasal air samplers¹²³ for 15 min. This finding is probably due to high concentrations of cat allergens in the dust reservoirs (such as carpets, soft furnishing, mattresses and also wall surfaces) of houses containing a cat.

Other anti-mite interventions

Various empiric approaches have been used to reduce mite allergens: freezing of household articles such as soft toys in a domestic freezer for 24 h,³⁸ the use of an electric heating carpet in the bedroom,¹²⁴ the use of an autoclave to heat rugs,¹²⁵ and hot tumble drying.¹²⁶ For those measures the experimental evidences are few and weak.

Recently, Goodman and Hughes¹²⁷ studied the effect of “corona discharge” on Der p 1. Their data provide evidence that corona products may be a powerful method for destroying Der p 1 allergens, independent of the presence of the oxidizing corona product ozone.

Special problems with pets

General considerations

Conflicting opinions still exist in the literature about the efficacy of prevention strategies to avoid exposure to the allergens of domestic animals particularly cats and dogs. Although the removal of these furred pets from domestic environment is usually considered the first-line measure from a clinical point of view, there is no documented report on the efficacy of cat/dog removal in reducing clinical symptoms in sensitized patients.

Many pet sensitized patients, particularly children, refuse to give up their animals.¹²⁸ Other patients, despite the obvious source of their symptoms, are often unwilling to recognize the correlation between pet-ownership and clinical symptoms and consequently refuse to remove their cats.¹²⁹ Finally, it has been shown that parents of cat allergic children (about 55%) deny that their child's symptoms are worsened by the pet's presence.¹³⁰ These are some of the reasons why, in the majority of cases, the eviction of pet allergens must be carried out with the animal standing at home.

Table 5 Anti-mite agents.

Agent	Mechanism
Benzyl benzoate, pyrethroids, disodium octaborate ¹¹³	Direct killing of mites
Natamycin	Reduces mite population via killing mold spores
Tannic acid	Denaturation of mite allergens
Liquid nitrogen	Direct killing of mites by freezing
Common salt	Killing by dehydration

The problem of the ubiquity of cat/dog allergens and possible prevention modalities

Even when furred pets (in particular cats) have been removed from the environment, it is unlikely that the exposure to allergens is completely abolished. In fact, there is a large body of evidence suggesting that cat allergen may be found in many indoor environments where cats have been removed from long periods.

Obviously, an intensive avoidance procedure (replacing furniture and blankets, vigorous vacuum cleaning, using air filtration systems) carried out after cat/dog removal, can significantly reduce the levels of Fel d 1 and Can f 1. However, it is unlikely that cat allergens are completely removed from a contaminated indoor environment. Many studies have shown that the majority of domestic environments (and public places) where a cat/dog has been never kept may contain significant amounts of Fel d 1 and Can f 1. In addition, some clinical data have proven that even low levels of cat allergens (found in indoor environments without cats) are able to induce respiratory symptoms in highly sensitive patients. Several authors have consistently demonstrated that the clothes of cat owners represent the main source for the dispersal of cat allergens in cat-free environments.¹³¹ We have recently shown that an indirect modality of allergic sensitization is possible also for other furry animals such as rabbit.¹³²

These considerations suggest that the removal of cat proteins from the clothes of cat owners may be an important approach for the prevention of dispersal of these allergens in animal-free environments.

Based on these premises, we designed a project to evaluate the efficacy of different methods of cleaning (with and without the use of water) materials passively contaminated by contact with cats. We demonstrated that Fel d 1 can be completely removed from contaminated cotton webs by simply washing them in water.¹³³ Also, we recently evaluated the efficacy of commercial dry cleaning that is commonly used in industrialized countries, using the same study design and a different type of material (wool). Dry cleaning was able to remove large amounts of Fel d 1 from contaminated wool fabrics but did not completely abolish cat allergen contamination.¹³⁴ Further, Fel d 1 contamination of three control (previously non-exposed) wool rectangles after dry cleaning suggested that cat allergens can be transferred from other clothes during the dry cleaning process.¹³⁴

Another recent study by Karlsson et al.¹³⁵ carried out in Swedish schools confirmed the role of clothing as reservoir of cat allergen. They demonstrated that the use of special school clothing (or ban pet ownership) were able to induce four- to six-fold lower airborne cat allergen levels in intervention classes compared with control classes.

Other modalities for removing cat allergens from indoor environments

It was suggested that washing domestic animals can be an efficient strategy to remove allergens from the body surface.¹³⁶ Unfortunately, the amount of pet allergens rapidly increases after washing and return to previous level within few days. Therefore, in order to achieve a satisfactory reduction of the allergen level, the dog should be washed one, or better two times a week.¹³⁷ It is important to remember that those frequent washing are not practically feasible because they induce serious dangerous effects on the fur by altering the lipidic film.

The aerodynamic properties of cat/dog allergens justify the use of air filtration systems in indoor environments containing these pets.^{50,138,139} The air cleaners or filters remove significant amounts of airborne Fel d 1/Can f 1 which represent the main risk factor for inducing clinical symptoms in cat/dog sensitized patients.

The use of a common furniture polish on either the dusty surfaces and the cleaning cloth during dusting was demonstrated useful in reducing both dust and cat allergens (Der p 1 and Fel d 1) dispersal.¹⁴⁰ Fel d 1 allergen can be successfully removed from hard floors by using electrostatic cloth sweepers, which are now easy to find.¹⁴¹ However, a recent study demonstrated that the common recommended intervention measures (cleaning all internal surfaces, removal of textiles, use of encasings, etc.) did not reduce the amounts of airborne cat allergen.¹⁴²

Concluding remarks

It is widely acknowledged that avoidance of allergens such as those derived from foods, drugs, latex and stinging insects results in a complete disappearance of symptoms. By contrast, although it has been clearly shown that allergens are an important risk factor for the development of respiratory symptoms and that several avoidance measures reduce allergen levels, whether this gives clinical improvement in symptoms is debatable.

Many reasons could be invoked to justify this evident discrepancy. Apart from the intrinsic methodological aspects (e.g. single or combined interventions measure, population, evaluated parameters, etc.), it is important to outline that a successful approach requires that the avoided allergen is the only and real factor responsible for symptoms, the patient's education and the use of a comprehensive protocol to reduce allergen exposure.^{36,143–147} Other important factors include the involvement of the patient, the relevance of other allergens, and exposure to sensitizing agents also outside patient's home.¹⁴⁸

In our opinion, the clinical phase of allergic airway disease and the degree of bronchial (and also nasal) remodelling, in each individual, represent relevant factors for the clinical success of allergen avoidance interventions. Since the management of respiratory allergy is a complex strategy (including drugs, prevention, immunological and educational interventions), it is difficult in real life to distinguish the efficacy of a single intervention in comparison to the others. A combined strategy is likely to produce better clinical results.¹⁴⁹

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