

EDITORIAL

Beds, bedrooms, bedding, and bugs: anything new between the sheets?

Since Voorhorst and Spieksma re-discovered house dust mites (HDM) in the 1960s, and suggested their role in allergic disease [1], mattresses and bedding materials have been recognized as the two major reservoirs of HDM and their allergens in the domestic environment. The bedroom and bedding in particular has naturally been singled out. As well as providing an ideal environment for HDM survival and proliferation due to a regular supply of moisture, warmth and skin as a food source, our sleeping environment is where we are destined to spend approximately one-third of our lives.

Very little is known about the determinants of HDM populations in different environments or of factors other than humidity that influence them. In some environments HDM appear more abundant in mattresses and in others, in carpets [2,3]. Similarly in some studies levels of allergen in bedding appear to be influenced by floor levels, as in the study in this issue by Custovic *et al.* [4], and in others, bedding allergen levels are thought to influence floor levels [2]. There certainly appears to be a traffic between various locations within the domestic environment.

Relative humidity is a major determinant of mite survival and proliferation. In dry cold winter climates, such as in Scandinavia, reducing indoor humidity by mechanical ventilation and heat recovery has proved an effective way of reducing or even eliminating HDM [5,6]. Mechanical ventilation systems are expensive and may not be sufficiently effective in HDM control in milder climates with high relative humidity levels all year round. It has also become apparent that HDM are able to withstand prolonged periods of lower humidity and can take on sufficient water for survival during brief periods of high humidity [7]. For these reasons bedding materials, with their high relative humidity while occupied, are ideal environments for HDM proliferation even where ambient relative humidity tends to be low.

Barrier covers have been advocated to trap HDM and their allergens inside the mattress. To be effective in controlling allergens, and to ensure comfort and compliance, covers should possess the following properties. There should be total occlusion to all allergens (not just HDM), covers should fully enclose the mattress, pillows and duvets, be waterproof, be sealed to prevent HDM colonization, be quiet in use, be durable, and must be permeable to moisture vapour to prevent rotting of the mattress [8]. For the latter there is a testing standard (SB 7209; 1990) for which a water vapour permeability index of more than 40% is considered

to be 'breathable'. While some studies demonstrated a reduction in HDM allergen levels with the use of mattress covers [9–12], others have not [13,14]. Differences in construction of covers, re-infestation of HDM from carpets, furniture and bedding, and inefficiency of cold washing of bedding to eliminate HDM may play a crucial role in the ability of covers to significantly reduce HDM and their allergens.

Other methods have been used to lower humidity in mattresses. For example Mosbech *et al.* demonstrated that local heating with electric blankets can reduce HDM numbers in mattresses [15]. In that study the electric blankets were switched on for at least 12 h during the day and resulted only in an average reduction of 40% in HDM numbers. This reduction is unlikely to be of long-term clinical benefit. If used on new mattresses with regular washing of bedding, electric blankets may prevent or delay HDM infestation. Ionisers have been actively promoted to asthmatics to control HDM. Warner *et al.* demonstrated that although airborne HDM allergen levels decreased significantly using deionisers, there was no significant change in symptoms, PEFR, or drug use [16]. Similarly a single portable dehumidifier centrally located in the house for 3 months was ineffective in reducing allergen levels [17]. One study using dehumidifiers in bedrooms in a subtropical area at sea level for at least 3 months did demonstrate an average reduction of greater than 50% of HDM allergens [18].

There are various chemical treatments of carpets to kill HDM and denature allergens. Traditionally acaricides such as benzyl benzoate to kill HDM, and tannic acid to denature allergens have been used either singly or in combination [14,19–23]. Generally the use of these chemicals causes only moderate reductions in HDM numbers and allergen levels. These reductions are not of long duration and repeated applications are necessary [23]. Tannic acid has also been shown to exert an inhibitory effect on the measurement of HDM allergens by ELISA techniques [22], thus probably over-estimating the reduction in allergen levels reported in earlier trials. Safety and toxicity studies of long-term exposure to acaricides are required. Application of liquid nitrogen to mattresses has successfully been used to kill HDM [24]. Repeated vacuuming after this treatment facilitates removal of dead HDM and allergens. However, liquid nitrogen is not cheap and requires specially trained operators for application [25]. Recently a domestic steam cleaner capable of delivering super-heated steam to the base

of carpets has been shown to both kill HDM and reduce allergen levels [26]. This study requires confirmation in field trials in a larger number of domestic dwellings and on woollen carpets.

Blankets are a major source of HDM allergens [27,28]. Studies of asthma prevalence in the Highlands of Papua New Guinea suggest that sensitivity to HDM and the subsequent development of asthma was attributable to the introduction of blankets [29]. Hot water washing ($> 55^{\circ}\text{C}$) kills mites but this is likely to damage blankets made from wool. Dry cleaning of woollen blankets is effective in reducing HDM allergens [28], most likely through the action of physical removal of the allergens that can also be achieved by cold water washing. Studies to determine the required frequencies of washing are needed. High numbers of HDM and high levels of their allergens have been demonstrated on pillows [30,31]. Regular hot washing of pillow-slips, encasement with covers, deep freezing, and direct exposure to sunlight [32] are effective measures to reduce HDM and allergens on pillows.

Carpets in the bedroom constitute a major reservoir of HDM and allergens. Regular domestic vacuum cleaning is ineffective in substantially reducing HDM. Indeed many vacuum cleaners leak detectable allergens into the air [33]. Repeated vacuuming does not cause an overall reduction in allergen concentration despite 8–10-fold reductions of total dust [34]; only with extremely intensive vacuuming are allergen levels reduced significantly [35]. Removal of carpets from the bedroom seems likely to be an effective strategy to reduce HDM numbers and minimizes HDM colonization and allergen transfer onto newly introduced bedroom furniture such as mattresses. Custovic *et al.*, in this issue, have shown that new mattresses rapidly accumulate allergens and that the levels in the new mattresses correlate with those in the bedroom carpet, a major source of allergens [4]. Mosbech *et al.* have also reported that HDM allergens accumulate quickly in new mattresses [36]. They also demonstrated no difference in allergen levels on heated waterbeds and in foam mattresses compared to conventional sprung mattresses. Thus advice to HDM-sensitive asthmatics to replace their old with new mattresses has little merit.

The message from our rather imperfect knowledge about HDM and their proliferation in the domestic environment seems to point towards a simple exclusive approach. Barrier covers for mattresses, pillows and duvets, synthetic bedding materials with regular hot washing and the removal of carpets, are likely to be the most useful approaches in reducing HDM in the bedroom. Recent studies show modest therapeutic effects of HDM allergen reduction in the bedroom [11,37]. Small scale studies are unlikely to give clear answers. For instance, to detect a two-fold reduction in allergen levels that is of statistical significance, at least 30 to 35 homes need to be studied [38].

Large long-term randomized controlled trials are required to determine whether these manoeuvres will really reduce the severity of HDM sensitive asthma and infant sensitization to HDM. If proven effective, major public health interventions will then be needed.

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