Efficacy of newly invented temperature and humidity control machine on house dust mite allergen and clinical symptom of dust mite sensitized allergic rhinitis children: a pilot study

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Short running title:

Abstract

Background:

House dust mite avoidance is advised in dust mite sensitized patients to decrease their risk of developing symptoms. Maintaining a relative humidity (RH) of less 50% is recommended for reducing the growth of dust mite.

Objective:

This study was to investigate the efficacy of temperature and humidity control machine on the level of dust mite allergens and total nasal symptom score (TNSS) in dust mite sensitized allergic rhinitis children.

Method:

Children (8-15 years) with dust mite sensitized persistentAR were enrolled. The temperature and humidity control machine was installed in the bedroom for 6 months. TNSSwas accessed before and every month after machine installingand the level of dust mite allergen (Der p1 and Der f1) from the mattress were measured before and every 2 months after machine installingusing enzyme-linked immunosorbent assay (ELISA).

Results:

A total of 7 children were enrolled. The reduction of Der f1 was demonstrated as early as 2 months after installing the machine but the significant difference was seen at 4 months and it was sustained low throughout 6 months ($p<0.05$). There was a modest but significantreduction in TNSS at 2 and 4 months ($p=0.003$). Seventy percent of the patients were able to stop using their intranasal corticosteroids. However, there was no correlation between TNSS and the level of dust mite antigen.

Conclusions:

The level of house dust mite in the mattress decreases after using temperature and humidity control machine. This machine mayhave a role in controlling clinical symptom of dust mite sensitized AR children.

Key words: Allergic rhinitis, Dust mite, Der p1, Der f1, children, relative humidity

Introduction

Allergic rhinitis is a common allergic disease worldwide. It has been proven that more than 600 million patients suffering worldwide. In Thailand, the prevalence of allergic rhinitis increased from 37.9% in the year 1995 to 50.6%in the year 2001.[1]

Clinical symptoms of allergic rhinitis consist of nasal itching, sneezing, watery nasal discharge, rhinorrhea, and blocked nose. Allergic rhinitis can be classified as intermittent or persistent and the severity from mild to severe. Medication treatments include antihistamine, oral leukotriene receptor antagonists, and topical nasal steroid depending on disease severity.[2] However, allergen avoidance is advocated as a central role for the managements of allergic rhinitis.[3]House dust mite is the most common aeroallergen sensitization in patients with respiratory allergy in tropical climate country such as Thailand and Singapore.[4, 5] A recent practice parameter has advised dust mite sensitized patients with asthma or rhinitis to minimize exposure to dust mite allergens to decrease their risk of developing of symptoms. Water balance is critical for house dust mite survival. The optimum relative humidity (RH) more than 65% isneeded to maintain their water balance and growth. If humidity decreases below 50%, mite proliferation decreases and survival is decreased. The temperature also has an impact on RH, as a result maintaining stable temperature is required to maintain a stable RH[6]. The present study was to investigate the effect of newly invented temperature and humidity control machine on the level of dust mite allergen and clinical symptom of dust mite sensitized allergic rhinitis children. This machine was invented by Dr. VeeraponMonyakul,KingMongkut's University of Technology Thonburi. This machine has been shown to provide a precise temperature and desired humidity in the room.[7]

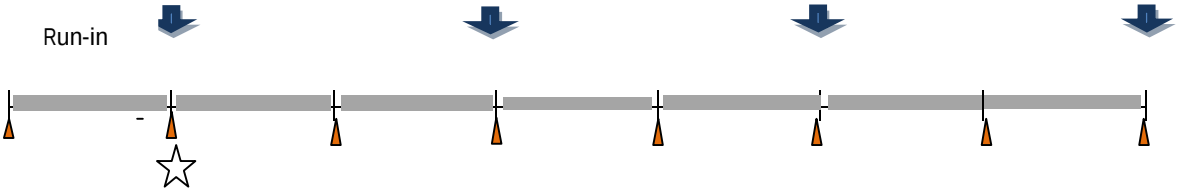
Patients and Methods

Patients

Children aged 8-15 year with persistent allergic rhinitis according to ARIA guideline who have skin prick test positive to house dust mites (Dermatophagoidespteronyssinus and/orDermatophagoides farina) and had symptom of allergic rhinitis related to the exposure to house dust mite were eligible for the study. Positive skin test was defined as a wheal diameter at least 5 mm larger than the control. Patients with multiple sensitization and previously or current on specific immunotherapy were excluded. Since the temperature and humidity control machine operate with air-conditioning and the machine was installed in the bedroom, the enrolled patients' must have air-conditioning in the bedroom.

Study protocol

This study is a 6 month experimental study with 1 month run in period. During running, intranasal corticosteroids were not allowed, but the patients were allowed to use decongestant and antihistamine and nasal irrigation. At V0, the patients were evaluated for total nasal symptom scores(TNSS) and dust mite collection from the mattress in the bedroom for dust mite antigen measurement. Then, clinical visit andTNSSwas assessed every month after machine installation in the bedroom. The dust mite antigens(Der p1 and Der f1) were measured every 2 months (Figure 1). TNSS was defined as the sum of the average score in the past 4 weeks for the 4 individual patients-reported nasal symptoms of congestion, itching, rhinorrhea, and sneezing (0-3 from mild to severe). After enrollment, patients were treated their rhinitis according to ARIA guideline[3] and received standard recommendation for dust mite control. The study was reviewed and approved by the human rights and ethic committee of Faculty of medicine, Ramathibodi Hospital, Mahidol University.All enrolled patients and guardian were explained and consented for the study.



Month 0 1 2 3 4 5 6

= dust mite collection

= physician visit

daily nasal symptom score record

= machine installation

Figure 1: Study protocol

The temperature and humidity control machine

The temperature and humidity control machine invented by Dr. VeeraponMonyakul, King Mongkut's University of Technology Thonburi, Bangkok, Thailand.[7]The temperature and humidity control machine consists of a unit of humidifier and a unit of dehumidifier withinthe same case. The device has the dimension of 0.3 x 1.0 x 1.2 meters (Width x Length x Height)and is similar to a 10,000 BTU air condition (type TURBO A.P.S., Saijo Denki International Co., MuangNonthaburi, Thailand).This device does operate with air-conditioningunder the automatic control by microprocessor in order to keep the relative humidity andtemperature constant at all times, 55% RH and 25 degrees Celsius. The device is installed and running incorporated with air-conditioning under the automatic control by microprocessor (Figure 2).Therefore, the temperature and humidity in testing room was

controlled to be as 25°C and 55% RH. This device has never been used as a commercial product.

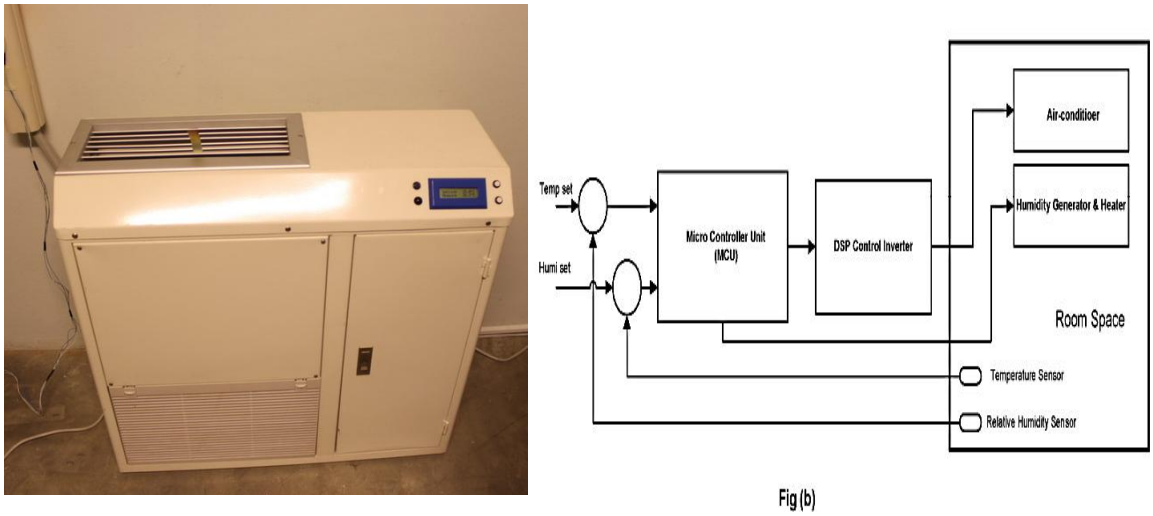


Fig (b)

Figure 2: The newly invented temperature and humidity control machine (A). Diagram demonstrating the operation system of the machine with the air condition(B).

Mite Allergen Measurement

Levels of Der p 1, the major allergen of Dermatophagoidespteronyssinus mites and Der f1, the major allergen of Dermatophagoides were measured using the commercial sandwiched ELISA reagents (Indoor Biotechnology, U.K.) at Siriraj Dust Mite Center for Services and Research Department of Parasitology, Faculty of Medicine Siriraj Hospital Mahidol University, Bangkok, Thailand. The lower detection limit is 0.2 microgram of Der f1 and Der p1 per gram dust.

Statistical analysis

Descriptive analysis was used to report the mean value and standard deviation (sd) of the data. Comparative analysis between pre and post machine installation was analyzed using paired Student's t test or ANOVA repeated tests. Correlation between TNSS and the level of dust mite antigen was analyzed using Pearson correlation.The differences with a p value

less than 0.05 were considered statistically significant. Data were analyzed using SigmaPlot 12.

Results

A total of 7 children with house dust mite sensitized allergic rhinitis were enrolled. Four children were male, mean age was 9.8 years, mean age of onset was 4 years and mean duration of symptom was 4 years. Three children also had asthma. Baseline characteristic of the patients was shown in table 1.

Table 1: Baseline characteristic of participating children

	Age (yr)	Sex	Duration of AR (yr)	Age of onset (yr)	Other allergic diseases	Severity of AR	Wheal size for DpbySPT	Wheal size for Df By SPT	Baseline TNSS
1	12	M	1	7	Drug allergy	Mild persistent	6*5	8*6 with pseudopod	3.45
2	12	F	7	4	AD,food allergy	Mild persistent	9*7	12*6 with pseudopod	1
3	8	M	2	6	No	Moderate persistent	10*5 with pseudopod	10*5 with pseudopod	6
4	8	M	6	2	Asthma	Mild persistent	7*7	10*6	1
5	11	F	4	7	Asthma	Moderate persistent	10*6	16*15	7.6
6	10	M	1	8	No	Mild persistent	10*25	10*8	3
7	8	F	7	1	Asthma	Mild persistent	17*15	23*13	1.83

AR : Allergic Rhinitis, SPT : Skin Prick Test, TNSS: Total Nasal Symptom Scores

Total nasal symptom score after installing the machine

Total nasal symptom score was significantly decreased after 2 months of installation the machine. However due to the variation in the total nasal symptom score and the small sample size, the statistically significant difference was seen only at 2 months and 4 months after installation (Figure 1). Five out of seven patients were able to stop using their intranasal corticosteroids.

The level of Der p1 and Der f1 after installation

There was are a reduction of the level of Der f1 as early as 2 months after installing the machine but the significant difference was demonstrated at 4 months and it was sustained low throughout 6 months ($p<0.05$) (Figure 2). However, the level of Der p1 in the mattress was lower than 0.2 ug/g dust in 6/7 houses resulting in the non-significant changes in the level of Der p1 (Figure 3).

The level of dust mite antigen and TNSS

There was no correlation between the TTNS and the level of Der f1 or Der p1 (Figure 4).Comparison between patient s who had baseline TNSS more than 3 and less than 3, there was no significant difference between the baseline level of Der f1 level (1.4 vs 2.5 ug/ gram dust, $p = 0.4$)

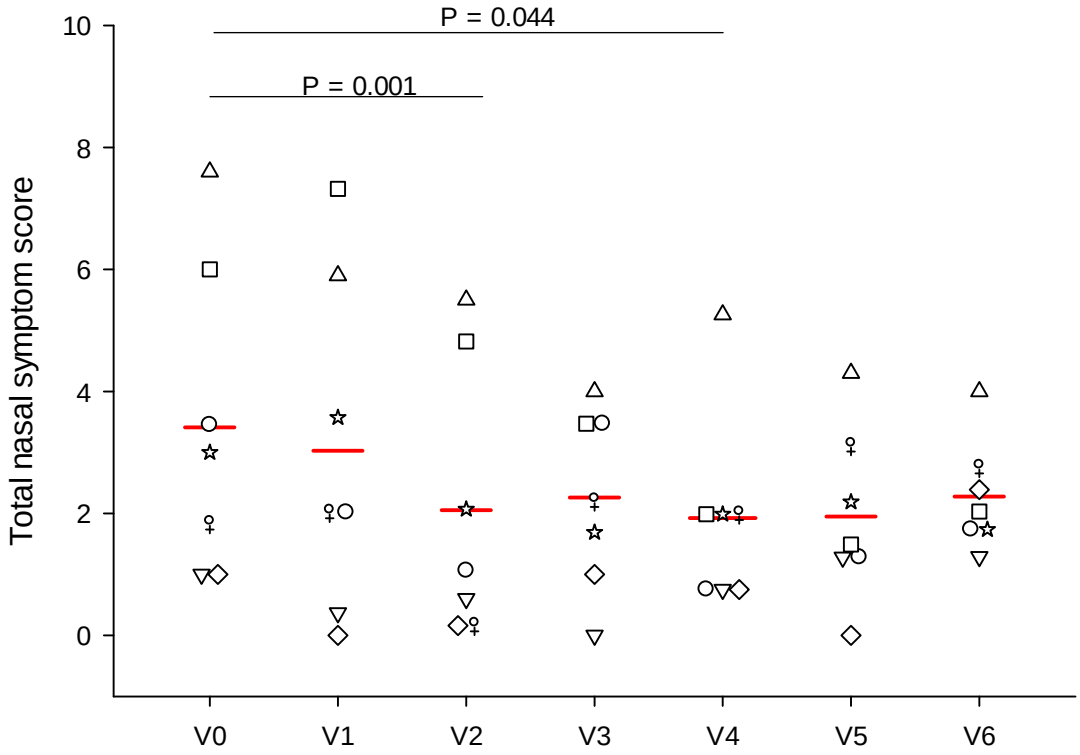
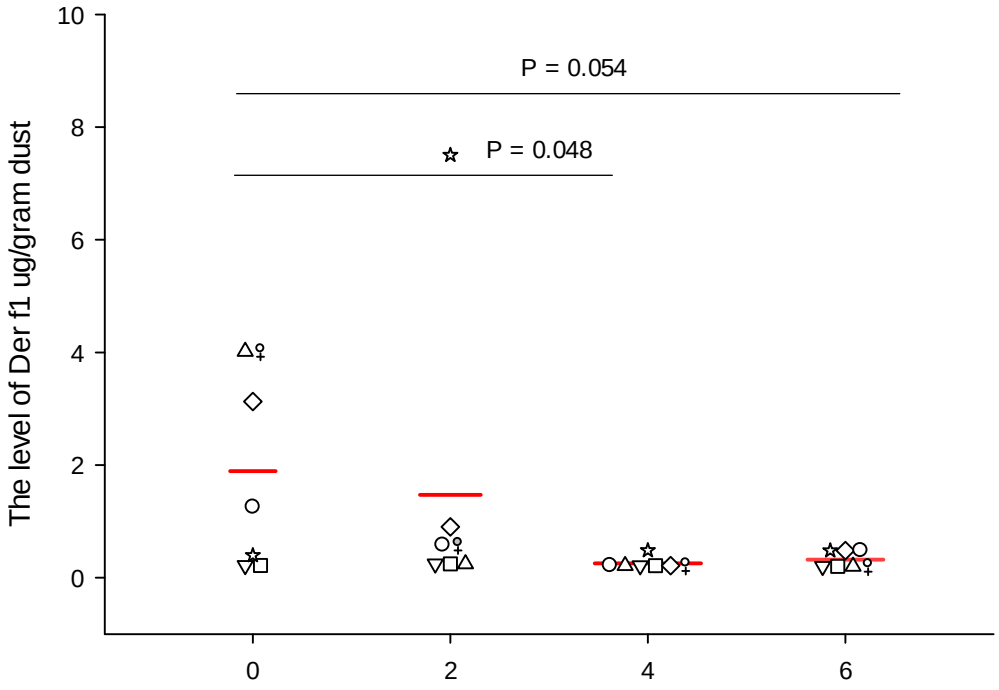


Figure 1 Clinical symptom score in each visit after machine installation. V0=before machine installation, V1,2,3,4,5, and 6 represent 1,2,3,4,5 and 6 months after installation respectively. Same symbol represents data from same subject.



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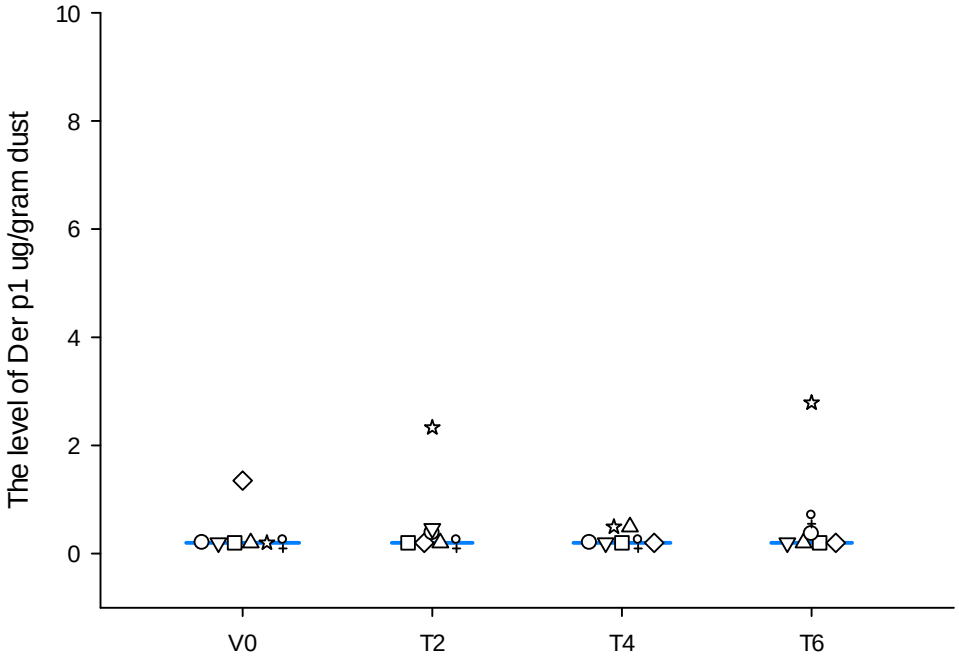

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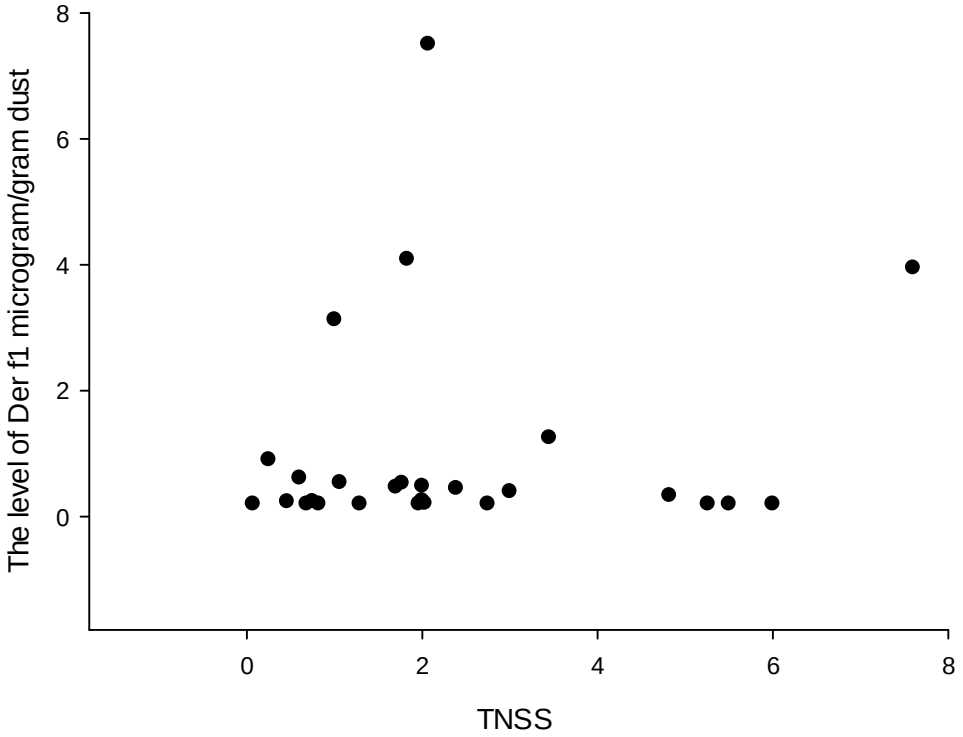
180 Figure 2 The level of house dust mite antigen Der f1 (A) and Der p1 (B) in each visit after
181 machine installation. V0=before machine installation, V2,4,6 represent 2,4 and 6 months
182 after installation respectively. Samesymbol represents data from same subject.



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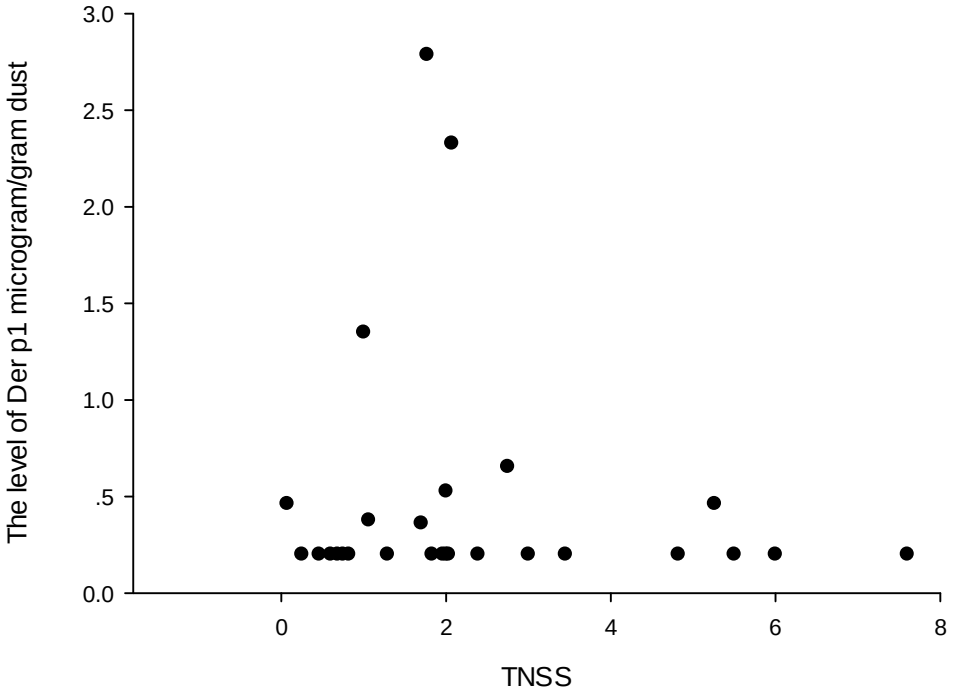

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185 Figure 3: The level of house dust mite antigen Der f1 (A) and Der p1 (B) and total nasal

186 symptom scores.

Discussion

House dust mite is the major allergen causing symptoms in respiratory allergy especially in tropical countries especially Thailand.[5]More than 70% of children with respiratory allergy were sensitized to house dust mites.[8]Current guidelines for allergic rhinitis and asthma management have emphasized on allergen avoidance and exposure control as a fundamental treatment in all step of treatment. Environmental exposure of dust mite can be controlled by removal of facilitative factor for mite growth and survival, clean or remove mite reservoirs and get rid of the mites.[6]The most important facilitative factor for mite survival is relative humidity (RH) in the ambient environment.[9]Maintaining RH in the house to less than 55% has been recommended to control dust mites and their allergen in homes in temperate climate[10] If there is a changing in temperature that results in increasing the RH only few hours can promote the growth of dust mites.[6]

The present study has demonstrated our newly invented temperature and humidity control machine was able to decrease the level of dust mite allergen in the bedroom of allergic rhinitis patients from Thailand, the high humidity country. Previous studies have shown the ineffectiveness of portable dehumidifiers in reduction the level of dust mite antigens.[11, 12]Since RH is temperature dependent. The advantage of this newlyl invented machine is the ability to maintain stable RH in conjunction with stable temperature by running incorporated with air-conditioning under the automatic control using microprocessor.[7] Previous study has been demonstrated that maintaining daily indoor relative humidity below 50% RH but allowing RH above 50% for more than 2 hours daily resulted in dust mite's population growth.[13] As a result, a portable dehumidifier in home use may not be able to control the dust mite population due to the inability to maintain stable temperature and RH throughout 24 hours.

After installing this novel machine, there was a modest but significantly improvement in total nasal symptom score as early as 2 months.However, there was no correlation with the level

dust mite antigen. Previous studies have recommended decreasing the level of Der p 1 and Der f 1 to lower than 2 microgram per gram dust in order to lower the risk of dust mite sensitization[14]. Exposure to 10 microgram of Der p 1 and Der f 1 per gram dust has been suggested as an exposure threshold for the development of asthma symptoms in already sensitized children[15]. In the present study, the levels of Der p 1 and Der f 1 from the bedrooms of the participating patients before machine installation were varied from 0.2-4 microgram per gram dust. Three out of seven subjects exposed to dust mite antigen lower than 2 microgram per gram dust. Consequently, the lower level of initial dust mite antigen may result in poorer correlation with the symptom improvements. In addition, forty percent of the participating patients had mild but persistent symptoms. The efficacy of the machine in reduction TTNS may be stronger if there were more severe patients enrolled. Since, the objective measurements such as rhinomanometry or nasal peak flow were not evaluated in the present study. The improvement in these objective measurements may be demonstrated early than the significant changes of clinical symptoms. There was a significant reduction of the level of dust mite antigen after machine installation. As a result, the significant improvement of clinical symptom may be demonstrated if the machine has been used for the longer duration.

The limitation of the present study is this novel machine is not commercially available and under developed. There are limited numbers of the machine which resulted in little number of enrolled patients. In addition due to the study period is 6 months, this may result in the difference in the season among patients. Nevertheless, this machine was demonstrated to be able to control the stable temperature and humidity,[7] the difference in the season should have minimal effect on the RH. There is no control patients in the present study, the placebo effect cannot be excluded for the improvement of the clinical symptoms.In addition, other methods that can control or decrease the level of dust mite were not monitor in the present

study.Further study on the efficacy of the machine in clinical practice needs more participating patients, longer duration of study and non-intervention group.

In conclusion, this pilot study has demonstrated that the newly invented temperature and humidity control machine was able to decrease the level of dust mite antigen in the bedroom of dust mite sensitized allergic rhinitis children. There was also a modest improvement in clinical symptoms of allergic rhinitis. Larger and well control studies are required to confirm the efficacy of this machine.

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