Susceptibility to Asthma Controlled by Modifying the Environment

Stephen Vesper

U.S. EPA/Office of Research and Development (ORD)/National Exposure Research Laboratory (NERL)

BACKGROUND:

Asthma afflicts about 6 million children in the U.S. resulting in medical cost of about $5 billion per year. Previously, we established that there were 26 molds that were statistically associated with water-damaged homes which we called Group 1 Molds (Vesper et al. 2004) and others which were common to all homes, i.e. the 10 Group 2 Molds. Analysis of these 36 molds makes up the ERMI© or EPA relative moldiness index©. We sought to determine if removing the water damage and molds reduced the asthmatic child's need for medical interventions.

METHODS:

1. Using EPA patented mold specific quantitative PCR (MSQPCR), mold concentrations were measured in dust samples obtained from water-damaged homes of asthmatics children in Cleveland, Ohio and results compared to a set of control homes. From this data and the resulting ERMI© values, an odds ratio for expressing asthma symptoms was established.
2. The water-damaged homes of half of the asthmatic children were remediated, i.e. water problem fixed and damaged materials and mold removed. The health outcomes were assessed.

Table 1. Comparison of mold populations in cell equivalents per g dust from asthma and control homes. (GM ratio = GM of asthmatic home/ GM of control home)

	Geometric Means (GM)				
Group 1	Asthma Homes (n=60)	Control Homes (n=22)	GM ratio	Wilcoxon Statistic	P Value
Aspergillus fumigatus	493.98	733.76	0.673	-0.823	0.411
Aspergillus ochraceus	1895.46	2117.95	0.895	-0.262	0.794
Aspergillus penicillioides	103285.40	72823.67	1.418	0.173	0.863
Aureobasidium pullulans	417991.00	727917.30	0.574	-2.329	0.020*
Aspergillus restrictus	227.79	298.52	0.763	-0.332	0.740
Aspergillus sclerotiorum	474.12	429.75	1.103	0.238	0.812
Aspergillus unguis	3831.60	1881.66	2.036	1.002	0.316
Aspergillus versicolor	4261.87	1948.05	2.188	0.839	0.402
Chaetomium globosum	1135.01	1438.13	0.789	-0.417	0.677
Cladosporium sphaerospemum	4714.39	8172.98	0.577	-2.204	0.028*
Eurotium amstelodami	149314.50	128746.90	1.160	0.392	0.695
Penicillium brevicompactum	3652.60	2353.54	1.552	0.483	0.629
Penicillium corylophilum	2317.31	1328.69	1.744	0.777	0.437
Penicillium Group 2	2604.09	654.49	3.979	1.764	0.078*
Penicillium purpurogenum	478.79	474.68	1.009	-0.051	0.959
Penicillium spinulosum	710.90	3600.06	0.197	-2.508	0.012*
Penicillium variabile	1050.69	1033.93	1.016	-0.101	0.920
Paecilomyces variotii	1718.81	1575.08	1.091	-0.090	0.929
Scopulariopsis brevicaulis	1179.00	480.64	2.453	2.112	0.035*
Scopulariopsis chartarum	446.12	577.68	0.772	-0.452	0.651
Stachybotrys chartarum	648.07	334.71	1.936	1.690	0.091*
Trichoderma viride	1602.96	284.82	5.628	2.601	0.009**
Wallemia sebi	18954.01	8442.97	2.245	1.952	0.051*
Group 2					
Alternaria alternata	16452.45	55594.45	0.296	-3.459	0.001***
Acremonium strictum	946.14	2177.42	0.435	-1.729	0.084*
Aspergillus ustus	1039.10	1794.22	0.579	-1.229	0.219
Cladosporium cladosporioides 1	177704.30	544160.00	0.327	-3.773	<0.001***
Cladosporium cladosporioides 2	16155.37	50671.42	0.319	-2.507	0.012*
Cladosporium herbarum	33532.34	48206.32	0.696	-0.947	0.344
Epicoccum nigrum	407868.70	920578.10	0.443	-3.093	0.002**
Mucor amphibiorum	12028.50	20292.92	0.593	-1.031	0.303
Penicillium chrysogenum	11362.78	11222.07	1.013	0.215	0.830
Rhizopus stolonifer	571.72	724.86	0.789	-0.818	0.413

*** p ≤ 0.001; ** p ≤ 0.01; * p ≤ 0.1

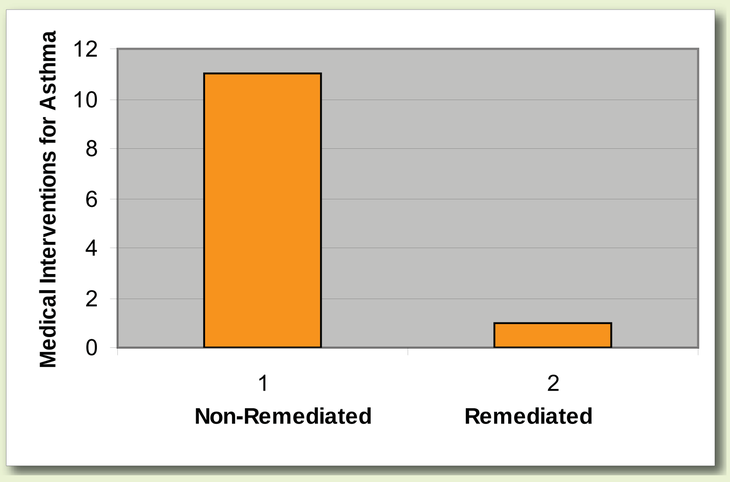
Molds associated with asthma

Table 2. Odds ratios for predicting illness based on relative moldiness index© (ERMI©).

RMI		True Negative	False Positive	False Negative	True Positive	No. correct	No. wrong	Odds ratio
-9		2	20	1	59	61	21	5.90
-8		2	20	1	59	61	21	5.90
-7		2	20	1	59	61	21	5.90
-6		2	20	1	59	61	21	5.90
-5		3	19	1	59	62	20	9.32
-4		5	17	2	58	63	19	8.53
-3		5	17	4	56	61	21	4.12
-2		6	16	6	54	60	22	3.38
-1		6	16	6	54	60	22	3.38
0		9	13	8	52	61	21	4.50
1		**11**	**11**	**10**	**50**	**61**	**21**	**5.00**
2		11	11	11	49	60	22	4.45
3		12	10	14	46	58	24	3.94
4		12	10	17	43	55	27	3.04
5		12	10	18	42	54	28	2.80
6		12	10	20	40	52	30	2.40
7		14	8	25	35	49	33	2.45
8		15	7	27	33	48	34	2.62
9		16	6	35	25	41	41	1.90
10		17	5	38	22	39	43	1.97
11		18	4	41	19	37	45	2.09
12		19	3	45	15	34	48	2.11
13		19	3	46	14	33	49	1.93
14		19	3	48	12	31	51	1.58
15		20	2	49	11	31	51	2.24
16		20	2	52	8	28	54	1.54
17		20	2	54	6	26	56	1.11
18		21	1	54	6	27	55	2.33
19		21	1	56	4	25	57	1.50
20		21	1	58	2	23	59	0.72
21		21	1	58	2	23	59	0.72

Predictive value of the relative moldiness index (ERMI©)
Table 2 shows the odds ratios for each of the ERMI© values. For example, a RMI of 1 has an odds ratio of 5.0. In this context, the odds ratio would quantify the relative proportion (relative risk) for the population of study homes of developing asthma. Therefore 61 of 82 homes would be correctly assessed, i.e. 50 true positives and 11 true negatives

Benefit: 10-Fold Reduction in Medical Intervention



Clinically, moderately severe asthmatic children had a significant decrease in symptom score ($p < 0.006$) and symptom days ($p < 0.003$) following remediation of their water- damaged homes.

RESULTS:

- Some of the Group 1 molds were associated with asthma in these water-damaged homes but none of the Group 2 molds.
- Determination of the ERMI© values produces a useful predictive model of asthma exacerbation.
- Removing the water damage and mold, produced a a ten-fold reduction in the need for medical intervention.

SIGNIFICANCE:

Determination of the ERMI© value in a water damaged home can be used in a cost benefit analysis and removal of water damage and molds can be used to reduce asthma costs in the US.

ACKNOWLEDGEMENTS

Primary funding for this research was provided by US Department of Housing and Urban Development, Office of Healthy Homes and Lead Hazard Control grant OHLHH0065-99. This research was partially supported by the Swetland Center for Environmental Health at CWRU and the National Institutes of Health General Clinical Research Center grant MO1RR00080. This research was also supported by US EPA Cooperative Agreement CR827942-01-0 and funds from the US EPA's National Center for Environmental Assessment's "Children at Risk" Program and "Asthma Initiative".

epascienceforum 2006
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