

A prospective evaluation of the adequacy of peak inspiratory flow rates and validation of the Turbutester score in asthmatic individuals with "low" peak expiratory flow rates: Implications for dry powder inhalers

To the Editor:

The negative impact of chlorofluorocarbons on the ozone layer has resulted in the development of novel dry powder inhalers (DPIs). The peak inspiratory flow rate (PIFR) has a direct influence on the amount of drug that is delivered to the lungs via these DPIs. Depending on its design, a propellant-free DPI requires a PIFR of ~ 15 to ~ 60 L/min for optimal drug deposition.

Borgstrom et al¹ studied the deposition of budesonide via the Pulmicort Turbuhaler (AstraZeneca Pharmaceuticals LP). At a PIFR of ~ 60 L/min, 27.7% of the drug was deposited; this compared with 14.8% at ~ 35 L/min. In a study of 101 adult patients with asthma,² the mean PIFR through a Turbuhaler was ~ 59 L/min (range, ~ 26 to ~ 103 L/min). Four patients had PIFRs below 30 L/min. In a study of children < 6 years of age,³ 15 of 57 subjects were unable to generate a PIFR < 30 , whereas all children ≥ 6 years of age successfully generated adequate PIFRs.

The possibility that asthmatic individuals with chronic severe airway obstruction or younger patients with low flows were not able to generate adequate PIFRs led us to prospectively examine flows in these patients, both quantitatively—by using an inspiratory flow meter—and qualitatively—via the generation of a Turbutester score.

The Turbutester is an instructional tool designed to help patients learn to use the Turbuhaler optimally. The Turbutester produces a whistle sound when the patient inhales

TABLE I. Baseline characteristics

Characteristic	Total n = 30
Age	
Mean (y)	58.2
Range (y)	8-90
8-10 y (n)	4
40-49 y (n)	3
50-59 y (n)	4
60-69 y (n)	9
70-79 y (n)	6
80-89 y (n)	4
Percent male	32.0
No. of asthma medications	
Mean	2.9
Range	1-7
No. of patients on daily or alternate day prednisone	7
No. of patients receiving prednisone bursts over the past year	9
Inhaled corticosteroid dosage: mean $\pm$ SD (μ g)	625 $\pm$ 378

deeply and forcefully, and the device is standardized ex vivo to produce this sound at a PIFR of < 45 L/min.

This was a prospective study carried out in a group allergy practice. All patients with the diagnosis of asthma who presented for initial or follow-up visits were screened for this study. Peak expiratory flow testing is routinely performed at these visits. A patient was eligible if he or she (1) had stable asthma with a "low" peak expiratory flow rate (PEFR) (< 260 L/min), (2) used asthma medication (of any kind) on an as-needed or regular basis, and (3) was capable of performing reproducible and technically adequate PEFR. Current and previous smokers were not excluded, and informed consent was obtained from every participant.

Spirometry was performed with a Burdick flow sensor; recordings obtained within the past 12 months were not repeated. Patients performed 3 PEFR measurements sequentially via a Mini-Wright peak flow meter. Patients were then coached on the use of the Turbutester, and the quality of each patient's efforts was assessed in triplicate, the best effort being recorded.

Turbutester measurements were scored according to the following scale: 0, no sound; 1, sound lasting < 1 second; 2, sound lasting 1 to 2 seconds; 3, sound lasting > 2 seconds.

To avoid investigator bias, the peak inspiratory flow was recorded in triplicate through use of the In-Check device (an inspiratory peak flow meter) only after the Turbutester score was assigned.

Thirty patients were eligible for this study (Table I). The population included 26 adults and 4 children (age range, 8 to 90 years). The baseline FEV₁ ranged from 17% to 105% of predicted normal. Seventy-three percent of the patients were atopic. Five patients had histories of smoking; 4 were current smokers. Nearly all patients (27 of 30) were currently on a regimen of high-potency inhaled corticosteroids (fluticasone propionate or budesonide).

TABLE II. Peak inspiratory and expiratory flow rates and FEV₁

Patient no.	PIFR (L/min)	PEFR		FEV ₁			Turbutester score (0-3)*
		L/min	Percent of predicted normal	L/s	Percent of predicted normal	Percent of FVC	
Children							
1	-100	260	95	1.02	105	110	1
2	-190	220	63	1.90	73	84	3
3	-200	240	75	1.75	86	102	2
4	-220	250	75	1.38	93	90	3
Adults							
5	-80	180	50	1.17	58	69	0
6	-90	220	62	0.44	20	42	0
7	-100	210	51	1.56	58	68	3
8	-130	210	57	1.15	55	62	3
9	-150	210	50	1.10	39	54	2
10	-150	100	25	0.90	44	42	1
11	-160	200	51	1.72	96	92	3
12	-170	250	45	1.23	45	79	2
13	-200	240	68	0.69	38	53	3
14	-200	240	59	1.60	82	70	3
15	-200	240	59	1.79	81	70	3
16	-230	250	57	0.79	31	44	3
17	-250	230	37	1.41	17	94	3
18	-250	190	39	1.76	69	73	2
19	-270	250	45	0.92	30	41	3
20	-50	70	18	0.42	21	42	0
21	-100	110	28	0.69	37	56	2
22	-160	170	43	0.99	46	58	3
23	-170	200	51	1.18	70	66	2
24	-250	210	48	0.90	44	49	3
25	-40	100	25	0.76	39	58	0
26	-100	170	40	0.91	37	64	2
27	-200	260	59	1.50	59	62	2
28	-210	210	55	1.37	43	57	3
29	-90	160	39	0.82	40	82	2
30	-50	70	18	0.42	21	42	0
Mean ± SD	159 ± 66	197 ± 57	49 ± 18	1.20 ± 0.41	53 ± 24	63 ± 15	2

PIFR, Peak inspiratory flow rate; PEFR, peak expiratory flow rate; FVC, forced vital capacity.

Three children had mild persistent asthma; 1 child had moderate asthma. Nineteen asthmatic adults had severe airway obstruction, 4 had moderately severe asthma, and 3 had mild persistent asthma.

The PIFRs for the 4 children (Table II, patients 1-4) ranged from -100 to -220 L/min; their PEFRs ranged from 220 to 260 L/min. All 4 children were able to produce an audible sound from the Turbutester; their scores ranged from 1 to 3.

The PIFRs for the 26 adults ranged from -80 to -270 L/min; their PEFRs ranged from 70 to 260 L/min. Every adult patient who was unable to produce a sound via the Turbutester had a PIFR that was in the lowest quartile.

If one assumes the optimal PIFR to be -60 L/min, the sensitivity of the Turbutester score was 100% and the specificity was 89%. The PEFR correlated moderately with the PIFR ($r = -0.66$). The FEV₁ correlated less well with both the PIFR ($r = -0.49$) and the PEFR ($r = 0.48$).

These data should reassure physicians; in a heterogeneous group of asthmatic individuals with low PIFRs, including 19 patients with severe obstructive airways disease, there were no patients who had air flows that were inadequate (<-30 L/min) for Pulmicort Turbuhaler deposition. In this most severe group, there were only 2 patients who had suboptimal inspiratory flow rates (<60 L/min). Other studies, however, have demonstrated small numbers of patients with inadequate PIFRs^{2,3}; accordingly, all patients with low PEFRs should be screened for adequacy of their PIFRs.

The Turbutester appears to be a reliable screening tool for identifying asthmatic patients who might have suboptimal inspiratory flow rates. Any patient with a score of 0 should be tested further with quantitative peak inspiratory flow measurements.

These data cannot necessarily be extrapolated to patients with acute asthma or patients with severe chronic bronchitis and emphysema.

Julian Melamed, MD
Wilfred Beaucher, MD
Allergy & Asthma Specialists
9 Village Square
Chelmsford, MA 01824

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Psychosomatic peanut allergy

To the Editor:

Peanut is the most common and most often life-threatening of all food allergies.¹ Patients who describe symptoms consistent with mast cell degranulation after the ingestion of peanut require evaluation for confirmation of specific IgE antibody and advice on avoidance and treatment of accidental ingestions. We report the case of a patient initially presumed to be allergic to peanut but whose reactions were ultimately believed to be psychosomatic.

The patient is a 27-year-old woman with allergic rhinitis and asthma. She stated that about 20 minutes after eating a peanut butter and jelly sandwich, she had itching and hives all over, as well as shortness of breath and wheezing. She went to the emergency department, where the written description of her physical examination included "diffuse rash over face, chest, back, arms and lower legs ... multiple scratch marks." She was treated with intravenous diphenhydramine, as well as oral prednisone and ranitidine. The next day she ate a peanut butter candy and had a similar reaction. Strongly suspecting that the reactions were due to peanut allergy, she presented to the allergy clinic for evaluation. A skin prick test was performed with a commercial extract of peanut (Hollister-Stier, Spokane, Wash), and the result was negative, with a positive histamine control producing 7-mm wheal and 50-mm flare responses. A crude extract was then prepared by mixing peanut butter with a small amount of saline. A skin prick test with this solution also produced a negative result. Despite the negative test results, given the convincing history, the patient was advised to strictly avoid peanut ingestion pending further evaluation. Serum was sent to a commercial laboratory (Allergy Testing Laboratory, Gainesville, Fla), where specific IgE antibody to peanut was undetectable.

An open challenge with one teaspoon of peanut butter was performed. Fifteen minutes after ingestion, the patient complained of itching and feeling warm. On examination, she was flushed and had hives on her arms and linear welts on her back from scratching. Her vital signs were normal, and she had no wheezing. She was treated with epinephrine and fexofenadine, and her symptoms resolved. Because of the positive open challenge result, additional in vitro testing was performed. Immunoblots for IgE antibody were performed with sev-

eral peanut extracts (by using methods previously described²) but failed to reveal any IgE binding.

The possibility of a psychosomatic reaction was raised in discussion with the patient. It was explained that the reactions were clearly not "all in her head" because the physical reactions had led 2 physicians to conclude that these were allergic reactions. Rather, the reactions were explained as possibly being due to her body's reaction to her mind's logical conclusion that she was allergic to peanut. She agreed to a double-blind, placebo-controlled challenge. Peanuts were chopped and mixed with chopped pecans and walnuts and cinnamon to conceal the taste. A similar concoction without peanuts was used as the placebo. Three blinded control tasters were unable to distinguish the peanut-containing mixture from that without peanuts. Additionally, for the challenge, the patient wore a nose clip to further decrease her sense of taste and used mouthwash immediately after each challenge ingestion. Both the patient and the observing physician were blinded as to the order of the challenge ingestions, 2 with peanut and 2 without. None of the 4 challenge ingestions resulted in any symptoms. The patient was informed of the results. She was subsequently challenged with 5 roasted peanuts and later with a teaspoon of peanut butter and again had no reaction.

On 3 separate occasions this patient had reactions to the ingestion of peanut that were consistent in terms of nature and timing with mast cell degranulation, including flushing, itching, and hives. The results of the first reaction were observed and treated by an emergency department physician. The third reaction, to an open challenge, was observed and treated by an allergist. Only after a negative double-blind, placebo-controlled challenge result did the patient consume peanut without reaction. This appears to represent a psychosomatic reaction. The linear nature of some of her welts suggests that she might have dermatographism, and thus some of her objective skin findings could have been self-induced. However, other findings, such as flushing and nummular hives, could not have been volitional. It is not clear why this patient had the reactions. Perhaps her original episode of hives was idiopathic and just happened to occur shortly after an ingestion of peanut. This could have led to her not illogical conclusion that she was allergic to peanut. After, and presumably as a result of, the negative blinded challenge result, she had no further reactions. Given the commonness and potential lethality of peanut allergy, an exhaustive search for confirmatory evidence of IgE antibody is appropriate in patients with convincing histories, and in most such cases, peanut-specific IgE is demonstrable. However, in some cases the allergic reaction might be psychosomatic. In such a case frank discussion with the patient and a double-blind, placebo-controlled food challenge might lead to a "cure."

John M. Kelso, MD^a
Cathie Connaughton, BS^b
Ricki M. Helm, PhD^b
Wesley Burks, MD^b
^aAllergy Division
Naval Medical Center