

Daily Peak Flow Measurements in the Assessment of Steroid Therapy for Airway Obstruction

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Summary: Measurements of peak expiratory flow can be made by outpatients on themselves. This technique, which may be carried out at home, has proved to be valuable in assessing the effect of steroids and other bronchodilator drugs in relieving airway obstruction.

Introduction

While there is no doubt that many patients with characteristic asthma are greatly improved by taking corticosteroids (Carrier, 1965; Walsh and Grant, 1966) it is often difficult to be sure that the improvement is due to the drug and is neither spontaneous nor psychogenic. Patients with chronic obstructive bronchitis or emphysema only occasionally respond to these drugs with measurable improvement (Corazza, Morrow, and Chesney, 1961; Clifton and Stuart-Harris, 1962; Beerel, Jick, and Tyler, 1963; Morgan and Rusche, 1964), although they often state that they feel better when taking them, or that their breathing is easier, in the absence of any improvement of ventilatory function. Other patients may show both subjective and objective benefit at the beginning of treatment but subsequently deteriorate despite its continuance, and it then seems possible that the early improvement may have been spontaneous and unrelated to the treatment. Isolated measurements on outpatients at intervals of a week or fortnight may be misleading because of random variations in severity of airways obstruction (Spicer and Kerr, 1966). This difficulty in assessing the response would not matter were it not for side-effects of prolonged corticosteroid treatment (Thorn, 1966). It is important to ensure that these powerful drugs are used only when they are really effective.

To overcome the disadvantage of isolated measurements on successive outpatient attendances we invite our patients to make their own daily measurements of peak expiratory flow (P.E.F.), using the Wright peak flow meter (Wright and McKerrow, 1959), while they are undergoing a therapeutic trial of prednisolone preceded by a period of administration of indistinguishable placebo tablets (Oppenheimer, Rigatto, and Fletcher, 1968). This is, in effect, an extension to outpatients of the method described by Walsh and Grant (1966).

Methods

The patients are given two boxes containing indistinguishable tablets. One box is labelled "for the first week" and contains lactose tablets identical in appearance to 5-mg. prednisolone tablets contained in the second box, which is labelled "for the second week." We usually start with a dose of 20 mg./day but may use a higher dose. The patient is given a form on which to record three readings of P.E.F. each morning and each evening and to record each day his ease of breathing by a letter; A meaning better than usual, B same as usual, and C worse than usual. He is also given a peak flow meter with instructions for its use and for completing the form. The

technique of using the peak flow meter is demonstrated, and care is taken to see that the patient uses it correctly. In assessing the significance of any change in P.E.F. we compare the means of readings on the last five days of each week because of the common delay in response to steroids. Since improvement may occur in asthma without any change in simple ventilatory tests, owing to a reduction in total lung capacity (T.L.C.) (Woolcock and Read, 1965), we usually measure airways conductance and lung volumes in a body plethysmograph (DuBois, Botelho, and Comroe, 1956; Guyatt, Alpers, Hill, and Bramley, 1967) at the beginning and end of the trial, and express the combined results as specific airways conductance (SGaw), which is airways conductance corrected for lung volume changes.

Results

The value and limitations of the method are best conveyed by results obtained in six patients with airways obstruction (Table I).

TABLE I.—Spirometric Measurements Before and After Isoprenaline Inhalation

Case No.	Age	Sex		F.E.V. ₁	V.C.	F.E.V. ₁ /V.C. (%)
1	44	F	Before	1.6	2.9	55
			After	1.9	3.1	61
2	39	M	Before	2.9	4.3	67
			After	3.3	4.4	75
3	68	M	Before	1.1	3.7	30
			After	1.3	3.8	34
4	62	M	Before	0.6	1.8	33
			After	0.8	2.2	36
5	54	M	Before	2.4	4.1	59
			After	2.8	4.5	62
6	65	M	Before	0.7	2.7	26
			After	0.9	2.8	32

Case 1

This case illustrates a prompt response to corticosteroids and the value of continued measurements during reduction to a low maintenance dose (Fig. 1). The patient, a 44-year-old woman, a non-smoker, had a 10-months history of daily cough and yellow sputum

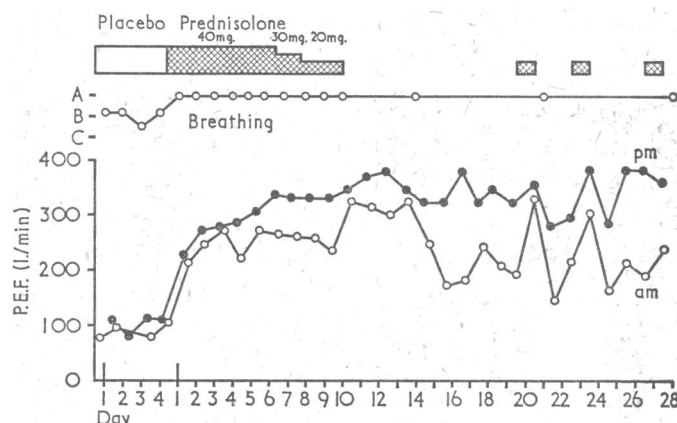


FIG. 1.—Case 1. Four days on placebo and then seven days on prednisolone 10 mg. six-hourly. Prompt subjective and objective improvement, which continued on change to intermittent dosage.

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TABLE II.—Peak Expiratory Flow and Dyspnoea Grading on Placebo and Prednisolone

Case No.	Mean P.E.F.—Placebo			Mean P.E.F.—Prednisolone			Change on Prednisolone (%)			Mean "Breathing" Marks‡		
	a.m.	p.m.	Daily	a.m.	p.m.	Daily	a.m.	p.m.	Daily	Placebo	Prednisolone	
1	87	99	93	239	291	265	+175*	+194*	+185*	1.8	3.0	
2 {	Week 1	333	362	341	420	491	419	+26*	+16*	+21*	2.1	3.0
	Week 2	198	201	200	441	452	447	+33*	+25*	+29*	3.0	3.0
3	73	62	68	247	264	255	+25†	+31*	+28*	2.7	3.0	
4	440	421	430	81	82	82	+11	+32*	+20*	2.3	3.0	
5	167	179	173	403	398	400	-8*	-6	-7*	2.1	3.0	
6				192	197	194	+15*	+10*	+12*	2.0	3.0	

* Change significant P < 0.001. † Change significant P < 0.01. ‡ A = 3. B = 2. C = 1.

accompanied by wheezing and shortness of breath. These symptoms had begun after an upper respiratory tract infection, and antibiotics had been prescribed with little benefit. There was a family history of asthma and eczema. Sputum was mucoid without any excess of eosinophils, but there was a blood eosinophilia of 600/cu. mm.; skin tests were negative; the chest x-ray picture was normal.

Placebo tablets were given for only four days because of increasingly severe dyspnoea. The mean of the P.E.F. readings during the first week on prednisolone (40 mg./day) increased by 185% over those obtained during the four days on placebo (Table II). There was also a marked improvement in SGaw and forced expired volume in one second (F.E.V.₁), while total lung capacity (T.L.C.) fell from 6.9 to 5.4 litres (Table III) and SGaw more than doubled. The patient was much less short of breath and her cough and sputum cleared. Daily measurements of P.E.F. were continued while the dose of prednisolone was reduced. After the drug had been stopped a high level of P.E.F. was maintained for four days; then the morning readings began to fall. Thereafter intermittent therapy maintained a satisfactory evening level with a slight reduction of P.E.F. on waking, which was readily overcome by isoprenaline aerosol.

TABLE III.—Physiological Measurements Before and After Prednisolone

Case No.	F.E.V. ₁ (l.)	V.C. (l.)	F.E.V. ₁ /V.C. (%)	T.L.C. (l.)	F.R.C. (l.)	R.V. (l.)	SGaw (Units)
1	Before	1.5	3.2	47	6.9	4.4	0.131
	After	2.5	3.8	68	5.4	3.5	0.290
2	Before	3.0	4.2	71	5.8	3.7	0.385
	After	—	—	—	—	—	—
3	Before	0.9	2.3	39	8.3	7.3	0.044
	After	1.9	4.2	45	9.0	6.9	0.092
4	Before	0.7	1.9	37	6.8	5.7	0.056
	After	1.2	2.7	44	4.5	2.8	0.206
5	Before	2.5	3.9	64	5.7	3.1	0.396
	After	2.5	4.0	63	5.5	2.9	0.310
6	Before	0.9	2.0	45	8.1	7.2	0.050
	After	1.0	2.6	39	8.4	7.2	0.071

Case 2

A 39-year-old man had had severe nasal obstruction and rhinorrhoea for several years. He had also had mild wheezing and shortness of breath without any seasonal variation for four years, but which had recently become much worse. Airways obstruction was mild (Table I). He was a non-smoker and had no sputum. He had a blood eosinophilia of 800/cu. mm.; the chest x-ray picture was normal; skin tests were positive to dust, grass pollen, and dog hair.

Considerable variation in the daily P.E.F. recordings occurred during the week on placebo; there was then a significant improvement during the first week on prednisolone (Fig. 2 and Table II), which continued during a second week. There was also definite subjective benefit.

Case 3

A man aged 68 had had cough and mucoid sputum, described as a "cigarette cough," for many years. He had smoked 60 cigarettes a day until two years previously, when he had stopped because of shortness of breath with wheezing, which was intermittently worse but which never remitted. There was no blood or sputum eosinophilia; the chest x-ray picture was normal; skin tests were negative.

Symptomatic improvement occurred on the dummy tablets and continued on prednisolone (Fig. 3). The P.E.F. readings varied from day to day with a tendency for the morning readings to be

lower. The mean daily readings were significantly higher in the second week on prednisolone (Table II). At the end of the second week F.E.V.₁, vital capacity (V.C.), and SGaw had all doubled (Table III). On continuing the prednisolone the improvement was maintained until withdrawal, when the patient became more wheezy and his F.E.V.₁ decreased. Prednisolone was then restarted and he has been maintained on a daily dose of 5–10 mg. with continued benefit.

The day-to-day variability in this case shows how misleading isolated readings could be in assessing the change on prednisolone. Full benefit took longer than one week to be established and it would have been better to continue the P.E.F. readings for at least one further week.

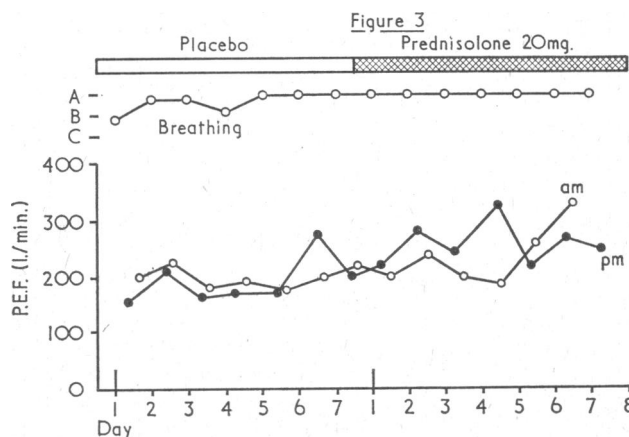
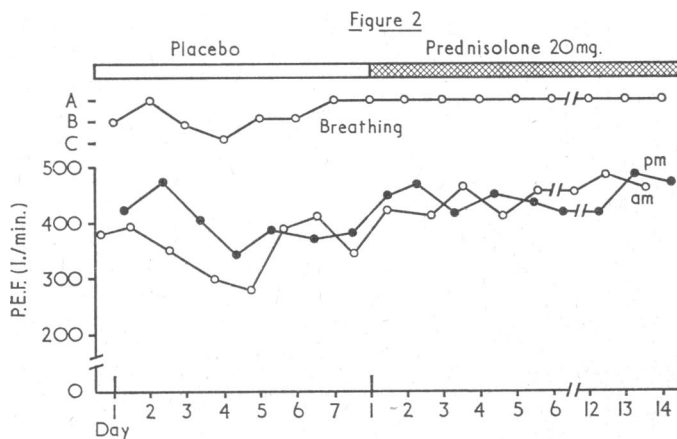


FIG. 2.—Case 2. Seven days on placebo and 14 days on prednisolone 10 mg. 12-hourly. Slow symptomatic and slight objective improvement maintained for two weeks. FIG. 3.—Case 3. Seven days on placebo and seven days on prednisolone 10 mg. 12-hourly. Subjective improvement preceding prednisolone. P.E.F. readings show variable but significant steady improvement in the second week.

Case 4

A 62-year-old man had a one-year history of shortness of breath on exertion and at night. He had smoked 10 cigarettes a day until he had stopped one year previously. There was no wheezing, cough, or sputum. There was no blood eosinophilia and the chest x-ray picture was normal. He had not improved on routine bronchodilator therapy.

The chart of P.E.F. readings (Fig. 4) shows no clear improvement, but the mean of the evening readings on the last five days he was on prednisolone was significantly higher than during the last five days on placebo (Table II). There was marked subjective improvement and a 70% increase in F.E.V.₁ and V.C. T.L.C. fell from 6.8 to 4.5 litres and SGaw showed a fourfold rise (Table III). This is an example of increased comfort in breathing being due to a fall in the T.L.C. (Woolcock and Read, 1965) with only a small change in P.E.F. readings.

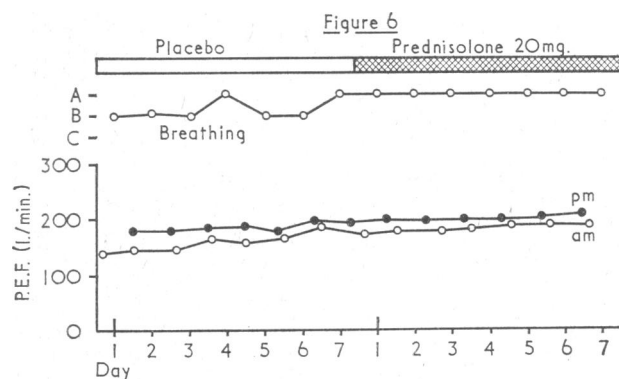
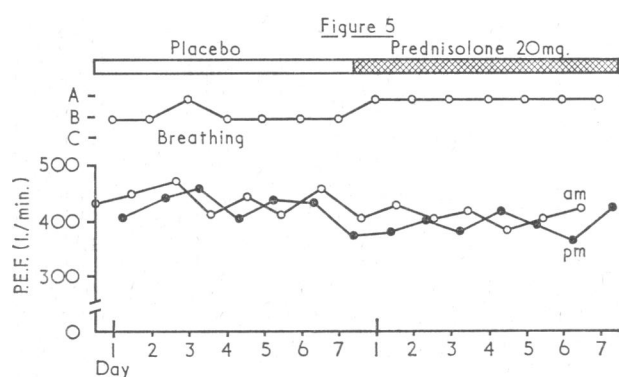
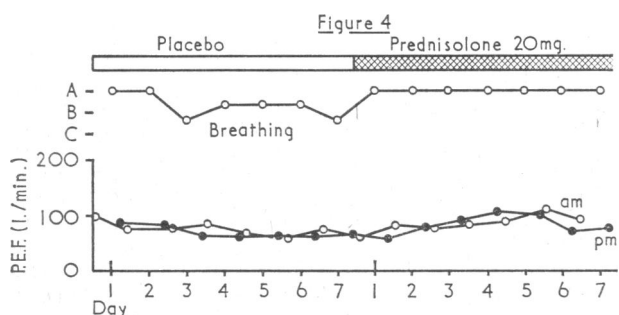


FIG. 4.—Case 4. Seven days on placebo and seven days on prednisolone 10 mg. 12-hourly. Prompt symptomatic improvement on prednisolone. P.E.F. readings appear constant, but in fact show 20% improvement, which is significant. FIG. 5.—Case 5. Seven days on placebo and seven days on prednisolone 10 mg. 12-hourly. Subjective improvement, but P.E.F. readings show slight deterioration. FIG. 6.—Case 6. Seven days on placebo and seven days on prednisolone 10 mg. 12-hourly. Subjective improvement on prednisolone. P.E.F. readings show steady slight improvement, starting on placebo and continuing on prednisolone.

Case 5

This 54-year-old man had a five-year history of perennial episodes of chest tightness. Serial measurements of F.E.V.₁ over a five-year period had shown a drop of 3.3 to 2.4 litres with a fall in F.E.V.₁/V.C.% indicating gradual development of mild but progressive chronic airway obstruction. He smoked 10 cigarettes a day, but had no cough or sputum. There was no significant blood eosinophilia and skin tests were negative. Chest x-ray examination showed a small bulla at the left base but was otherwise normal.

Despite definite subjective improvement the daily P.E.F. readings were actually lower on prednisolone than on placebo (Fig. 5). There was no significant change in F.E.V.₁, V.C., T.L.C., or SGaw. In this patient the subjective improvement was shown not to be due to relief of airway obstruction, and it was clear that further use of prednisolone would be of no benefit.

Case 6

A 65-year-old man had had winter cough and sputum for 20 years. For 10 years he had had increasing shortness of breath, which was worse during the winter. He had smoked 20 cigarettes a day until four years previously; since then he had reduced the number to one or two a day. There was no significant blood or sputum eosinophilia. Chest x-ray examination showed some evidence of emphysema. Skin tests were slightly positive for house dust.

He recorded a definite improvement in his breathing when he started prednisolone: the P.E.F. readings showed a steady slight but significant improvement both in the morning and in the evening throughout the two weeks (Table II, Fig. 6). There was a slight increase in V.C. but no significant change in F.E.V.₁. SGaw rose by 42%. The demonstration that improvement, though slight, had started while on dummy tablets and did not increase on prednisolone tablets showed that it was spontaneous and not due to the treatment. When the prednisolone was stopped there was no deterioration.

Discussion

We have now used this technique in more than 50 patients and have found it to be a valuable addition to other measurements of lung function which can be done only in the clinic. Since improvement on steroid drugs may take more than five days to be established we now extend the period of measurements for a third week when necessary, and use it to guide the establishment of maintenance therapy, as in Case 1. The technique may be useful in reverse, as was shown by one patient who appeared to be taking steroids without much benefit. P.E.F. readings taken for a week without any change in steroid dosage and for two weeks after substitution of dummy tablets showed no change. Steroids were then discontinued. We have also used this technique in testing other bronchodilator drugs.

In a department such as ours, in which up to 10 outpatients are undergoing therapeutic tests every week, we find we need 12 instruments. All our patients have used them carefully and have returned them undamaged.

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