A NEW TYPE OF PEAK FLOW METER ASSESSED IN GENERAL PRACTICE

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BECAUSE of the ease with which it can be measured by instruments of simple design and relatively small cost, peak expiratory flow rate (P.E.F.) is ideally suited for use in general practice as an index of bronchial airway obstruction. It is the writer's view that this test is invaluable in the management of asthma and chronic bronchitis.

Two types of meter for measuring P.E.F. are on the market. The Wright meter was introduced in 1959: a detailed survey of its use in general practice is published elsewhere (Gregg, 1964). On the Continent an entirely different type of peak flow meter has been in wide use since 1955 and within the last two years it has been introduced into this country. This meter, named after its inventor, is the Hildebrandt pneumometer.

This paper reports a study undertaken in general practice to assess the Hildebrandt pneumometer with special reference to the requirements of the general practitioner.

Principles of operation

The Hildebrandt pneumometer (figure 1) operates on a different principle from that used in the Wright meter. It is essentially an aneroid manometer. There is a blow-tube, approximately one inch in diameter and five inches in length, down which the subject blows when performing the test. At the distal end of this blow-tube a smaller inner tube is interposed at right angles. The inner tube has a specially shaped orifice which faces against the direction of the subject's expiration. A forced expiration creates a pressure differential at this orifice which is transmitted from the inner tube to a small manometer via a length of rubber tubing. The change in pressure causes a pointer in the manometer to move across a calibrated scale until it is held automatically at the point of maximal deflection. On pressing a release button the pointer returns to zero.

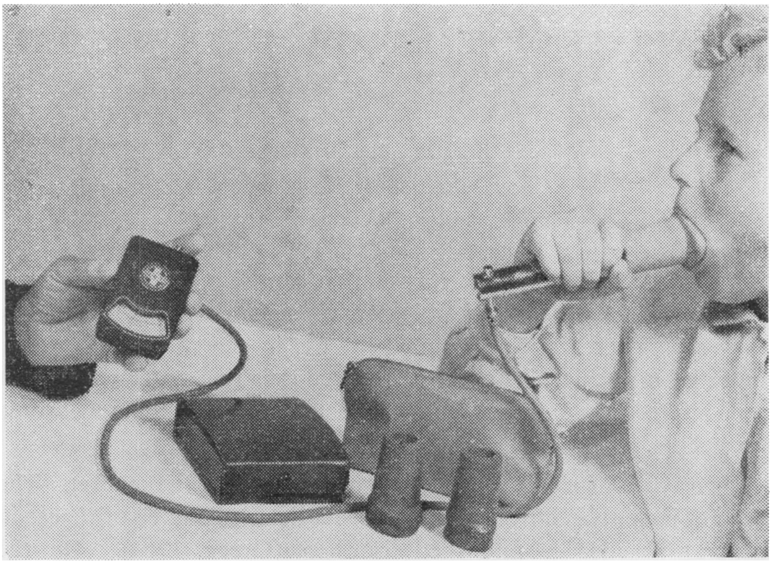

Figure 1
THE HILDEBRANDT PNEUMOMETER
This shows the instrument in use. The blow-tube is connected by rubber tubing to the manometer held in the doctor's hand.

Description of instrument. The Hildebrandt pneumometer consists of two main parts—the chromium plated blow-tube and the manometer, these being connected to one another by a three-foot length of rubber tubing. It is a smaller and lighter instrument than the Wright meter, its combined weight being only 12 ounces. The manometer is small enough to be held in the hand. The dissembled parts of the pneumometer can be packed into a leather case measuring four by six inches.

Three mouthpieces (of different sizes) are supplied with the instrument. These are made of sponge rubber and are specially designed with the object of forcing the mouth open as widely as possible.

The price of the Hildebrandt pneumometer, including the leather case and three mouthpieces, is £19.19.0 (the Wright meter's price being £29).

Calibration. The dial of the manometer is calibrated in litres and half-litres per *second*. (It is important to note that the Wright meter is calibrated in litres per *minute*). Any recordings which do not fall exactly on one of the litre or half-litre divisions must be estimated approximately.

Performance of the test. The same considerations of careful, preliminary explanation and encouragement to the subject to make his maximal effort apply equally whether P.E.F. is measured by the Hildebrandt pneumometer or the Wright meter.

The instructions issued with the pneumometer recommend that the subject should *first* place the instrument in his mouth, then take in as deep a breath as he can, and finally make the forced expiration on which the test depends. This technique differs from that which is used for the Wright meter, when the subject breathes in maximally *before* placing the instrument in his mouth. For reasons to be discussed, the latter technique is greatly preferable to that which is advocated for the pneumometer.

Sterilization. The rubber mouthpieces are readily sterilized by boiling or immersion in cetavlon. The chromium-plated blow-tube can be sterilized by boiling but it is important that the locking screw, which holds in place the small inner tube, is first loosened. After sterilization all the inside surfaces of the blow-tube must be thoroughly dried and the locking screw must be retightened.

Use of the pneumometer

General aspects. If the technique recommended in the instructions is followed when performing the test, there is clearly a risk of cross-infection occurring unless the blow-tube is sterilized after every test, which is impractical. This risk is especially great when the test is performed on chronic bronchitics. Since it is most undesirable to breathe in through the blow-tube which may have been contaminated by a previous user's expired breath, it is advisable to perform the test following the same technique as is used for the Wright meter. This overcomes the danger of cross-infection and disposes of the need for repeated sterilization. I carried out tests on several subjects to find out if there was any difference in the recordings obtained by the two techniques and I did not find any discrepancy.

I soon gave up using the provided rubber mouthpieces, as they had no special advantage. Indeed, the perpetual need to sterilize these mouthpieces was a great inconvenience. Instead of the provided mouthpieces, I used disposable cardboard ones (of the type designed for the Wright meter). With a little adaptation these can be made to fit the blow-tube of the pneumometer.

The calibrated dial on the manometer gives only litre and half-litre divisions. Hence any intermediate positions have to be roughly estimated. This compares unfavourably with the Wright meter which is calibrated to the nearest five litres per minute (or 0.083 litres per second).

Accuracy of the pneumometer. Only limited information concerning calibration and accuracy tests which had been performed on the pneumometer was forthcoming from Germany. It is generally considered that flow meters which employ an aneroid principle are subject to certain inherent inaccuracies (Wright and McKerrow, 1959).

On comparing readings of P.E.F. given by the pneumometer with those obtained with the Wright meter when subjects were tested with each in turn, I found that there was a consistent tendency for the former to be higher. This discrepancy could have been due to a failure on the subject's part to make a maximal effort with each meter. Therefore, in order to compare the two meters directly, it was clearly essential that both should measure the self-same expiration. In an attempt to achieve this, I devised the following experiment. The two meters were connected together in series, so that the subject's forced expiration passed, first down the blow-tube of the pneumometer and then directly into the Wright meter. Figure 2 and table 1 show the results obtained in this experiment.

The readings given by the pneumometer (in litres per second) were multiplied by 60, so that the values of P.E.F. given by both instruments could be expressed in litres per minute. In figure 2 each reading given by the pneumometer is plotted against the simultaneous reading of the Wright meter. If both meters had given identical values, these would all have fallen on the 45 degrees congruence line. It will be seen at once that the pneumometer gave consistently higher readings than the Wright meter. In the 0–500 L/min. range the two meters showed reasonably close agreement, but at the higher ranges of P.E.F. there was a greater discrepancy. It should be noted the discrepancy between the meters cannot be accounted for simply by the difficulty of obtaining exact readings on the pneumometer due to its inadequately calibrated scale: in table 1 it will be seen that there is a discrepancy between the meters even when the pneumometer readings fell exactly on one of the litre or half-litre divisions of the scale.

The experiment is open to the criticism that either of the meters' performance may have been disturbed by the close proximity of the other in series with it. This possibility, though it is unlikely to have been a very significant factor, must nevertheless be taken into account.

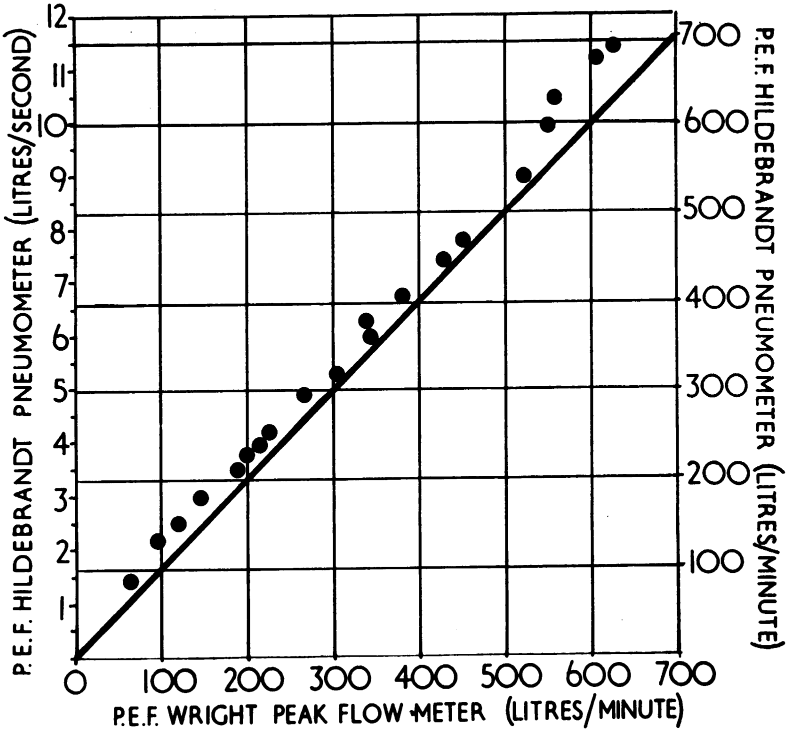

Figure 2

Direct comparison of Hildebrandt pneumometer with Wright peak flow meter (see text).

The discrepancy between the meters may, in part, be explained by the fact that the pneumometer is not damped, whereas the Wright meter is intentionally damped so that it will only record a peak-flow if it is sustained for at least 10 milli-seconds.

Discussion

The Hildebrandt pneumometer was originally designed for use by general practitioners who required a reasonably accurate test of ventilatory capacity. Its smaller size and lower cost, compared to the Wright meter, are self-evident advantages to the general practitioner. Though its appearance is less robust than the Wright meter, reports of its use on the Continent claim that it maintains its accuracy over long periods (Hildebrandt, personal communication).

From the reports of its wide use on the Continent and from my own experience of using it in general practice, the pneumometer would appear to be a satisfactory instrument provided that its limitations are recognized. It is sufficiently accurate for most purposes in diagnosis. It would enable the general practitioner to diagnose mild degrees of bronchial obstruction with much greater confidence than is possible by clinical methods alone. It could also be used to assess the reversibility of obstruction by bronchodilator drugs.

TABLE I

DIRECT COMPARISON OF HILDEBRANDT PNEUMOMETER AND WRIGHT PEAK FLOW METER

Hildebrandt L/sec.	= L/min.	*Wright* L/min.
1.4	84	65
2.2	132	95
2.5	150	120
3.0	180	145
3.5	210	190
3.75	225	200
3.9	234	210
4.0	240	220
4.9	294	265
5.2	312	310
6.0	360	345
6.3	378	340
6.75	405	380
7.4	444	430
7.75	465	455
9.0	540	525
10.0	600	550
10.5	630	560
11.25	675	610
11.5	690	630

Note—The values in *italic* are those which were found when the pointer of the Hildebrandt pneumometer corresponded exactly with one of the litre or half-litre divisions on the scale.

Undoubtedly the pneumometer is not such an accurate instrument as the Wright meter. This is chiefly because the calibrated dial on the manometer has insufficient divisions marked on it, which necessitates approximation of readings. Another serious objection to the pneumometer is suggested by the tests which I performed when the meters were compared with each other. It would seem that readings made with a pneumometer are not directly comparable with those given by a Wright meter. It is clearly desirable that P.E.F. measurements made by general practitioners should be directly comparable with those made in hospitals and chest clinics where the Wright meter is now firmly established.

The Hildebrandt pneumometer is not to be recommended for research purposes. Apart from the difficulty of reading values accurately, due to the inadequately marked scale, doubt has been cast upon the inherent accuracy of aneroid-type flow meters. Much greater confidence can be placed in the Wright meter. Calibration tests performed on the latter have revealed its accuracy to be of a very high order (Wright and McKerrow, 1959). The results of my own tests on the accuracy of the pneumometer must be interpreted with caution, but they suggest that the latter instrument is less accurate especially at the higher ranges of P.E.F. On the Continent the Hildebrandt pneumometer has been used for objective tests to assess the duration of action of a new bronchodilator—orciprenaline (Zidek, 1961).

Summary and conclusions

Measurement of P.E.F. deserves a prominent place among the routine diagnostic methods used by general practitioners. A peak flow meter is indispensable for the diagnosis and management of any chest disease in which there is bronchial airway obstruction.

The Hildebrandt pneumometer is satisfactory for most routine purposes, but it is a less accurate instrument than the Wright meter and is not recommended for research.

The technique for performing the test which is recommended in the instructions accompanying the Hildebrandt pneumometer carries a danger of cross-infection. It is advisable to use an alternative technique which overcomes this risk.

It is suggested that P.E.F. measurements made with the Hildebrandt pneumometer are not directly comparable with those given by the Wright meter.

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