Contemporary Themes

A miniature Wright peak-flow meter

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Summary and conclusions

A new miniature Wright peak-flow meter has been designed and produced. The meter is tubular with a spring-loaded piston and a longitudinal slot through which air escapes. Its dynamic characteristics have been carefully designed to make it respond only to peak flow and not to rate of rise. Performance tests on early instruments showed fairly close correlation with the Wright peak-flow meter but with a constant error of +38 l/min. On later models the correlation was increased to 0·990 and the error reduced to +3%.

The mini-meter correlates as well with the standard instrument as two standard instruments correlate with each other and should prove useful clinically.

Introduction

The Wright peak-flow meter, which was designed as a "simple and reliable device for measuring the maximum expiratory flow rate during a forced expiration,"[1] is now in worldwide use as a measure of ventilatory capacity.

The instrument's popularity has been due partly to its portability and simplicity: patients taking part in therapeutic trials could take the instrument home and make their own measurements and so avoid admission to hospital. This practice was largely responsible for showing the value of disodium chromoglycate in asthma; occasional tests in clinics had previously shown the drug to be of little value.[2]

Nevertheless, the instrument is rather expensive, cumbersome, and unnecessarily precise for these clinical uses as it was originally designed for epidemiological studies. This paper describes a simpler version of the meter.

Evolution of the new instrument

The first attempt at a simplified design was the "de Bono whistle."[3] Described in 1963, this was a tube with a longitudinal slot and a whistle in the end. It fitted inside a standard cardboard mouthpiece, and the length of slot uncovered was adjusted until the subject could only just blow the whistle. The device did not survive because it was difficult to hear the short, faint whistle produced when near the end point and because the test usually required several attempts and some disabled people can give only one peak expiration at a time.

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I adopted the idea of a tubular instrument in 1965, when a prototype was constructed with a light spring-loaded piston and a longitudinal slot as the variable orifice, in which was carried a rider as peak indicator. Clinical tests showed that readings from the new instrument correlated well with those from the standard peak-flow meter and that it was acceptable to patients, particularly young children, because of its smaller size. When it was produced commercially in 1973, however, as the Peak Flow Gauge changes in its design had altered its dynamic properties so that its readings did not correlate well with those of the standard model.[4]

Meanwhile development continued and the instrument reached its present form in 1969, though it has been in commercial production only since 1977 as the mini Wright peak-flow meter (figs 1 and 2).

FIG 1—Mini-Wright peak-flow meter showing correct method of use.

Operation and use

Air blown into the instrument cannot escape (except for a small amount which leaks past the piston) until it has moved and uncovered part of the slot. When the area of slot uncovered is such that the pressure behind the piston is just enough to balance the force of the spring, the piston comes to rest in a position that depends on the flow rate. Thus, under steady-flow conditions the instrument's calibration depends only on its geometry and the characteristics of its spring. Under dynamic conditions with rapidly changing flow rates, as during a peak expiration, the mass of the piston is equally important. Unless it is light enough in comparison with the controlling forces the piston may overshoot, so that the reading is affected not only by the magnitude of the peak flow but also by its rate of rise. The mass of the piston has therefore been reduced to the minimum possible.

The instrument is used in the same way as the standard model. It may be held in either hand, but the slot must face away from the hand (as shown in fig 1), so that air can escape freely. As it is not affected by gravity it need not be held horizontally. The valve prevents the return of the piston blowing back into the subject's mouth.

Cleaning and disinfection—The instrument may be cleaned easily in running water or in a detergent solution. The mouthpiece may be

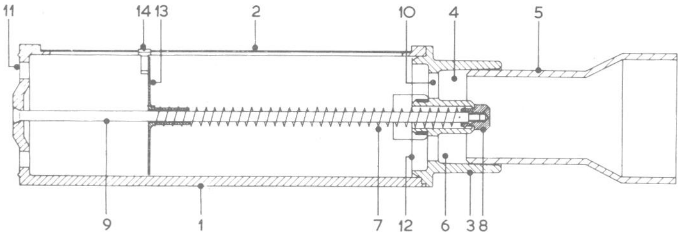

FIG 2—Diagram of mini-Wright peak-flow meter. The cylindrical body (1) and one end of the instrument are moulded in one piece with a slot (2) down one side. The other end (3) carries a tapered socket (4) which accepts a sterilisable mouthpiece (5) or a disposable cardboard mouthpiece. It has a central hollow boss (6) which houses a tension spring (7). The mouthpiece end is held to the body by a knurled nut (8) screwed on to the threaded end of a central rod (9), the other end of which is secured in the fixed end of the body.

Both ends are hexagonal in section to prevent the instrument from rolling and are pierced by a ring of six holes (10, 11) to allow free passage of air. A thin PTFE disc valve (12) is secured to the boss inside the mouthpiece end. The piston (13), which is a light plastic disc with a short sleeve, rides freely on the rod and just clear of the cylinder bore. The scale, which is read vertically, is marked in l/min from 60-800, but a scale in l/s to conform with SI units will be available if required. The rider (14) is spring-loaded in the slot with sufficient friction to prevent it overshooting without appreciably affecting movement of the piston.

The meter is 5·0 cm in diameter and 15 cm long, and weighs 75 g.

autoclaved but the instrument itself must not be heated above 75°C. Details of sterilisation methods are supplied with each instrument.

Calibration—As all parts are moulded in plastic, except for the spring, which is calibrated by its makers, and the metal central rod and nut, only steady-flow calibration is required; this is carried out before the scale is attached. For most purposes two operators with widely differing but stable PEFRs can check the calibration for themselves using a standard peak-flow meter as reference.

Performance

The instrument has been tested by several workers. Perks *et al*[10] found a correlation coefficient of 0·970 with the standard instrument on a hundred pairs of PEF measurements ranging from 100 to 700 l/min, but with a constant error of +38 l/min. They noted that this error was being corrected in later instruments. Pride (N R Pride, personal communication) in a study of 14 paired observations over a similar range found a correlation coefficient of 0·990. McDermot and Oldham (M McDermot and H G Oldham, personal communication) studied the mini-meter at various times during its production. With early models they found the same high readings as Perks *et al* but with later models the error was reduced to +3%, and the correlation coefficient was 0·990 on a group of 44 comparisons.

In all these studies subjects blew alternately through the two instruments in a randomised fashion. This was the procedure followed by Wright and McKerrow and was unavoidable because of the nature of the standard peak-flow meter and the pneumotachograph with which it was compared. It does, however, inevitably increase the scatter, as the breaths measured are not the same.

The mini-meter, however, being small and tubular, lends itself to being enclosed in a case and connected in series with a standard peak-flow meter. When this was done the correlation coefficient rose to 0·995, which was a significant improvement. For practical purposes therefore the performance of the mini-meter is identical with that of the standard instrument.

Discussion

When the peak-flow meter was first described the importance of a physically correct measurement was emphasised: the measurement should be absolute and clearly defined so that it would be the same however and wherever it was measured.[1]

Since the peak-flow meter was developed several similar devices have been produced in addition to the de Bono whistle. The Floscope[5] and Pneumometer[6] both measure the pressure drop through a fixed orifice. Results with the Floscope seem to correlate well with those of the peak-flow meter, but the need to change orifices to get the right range for the patient means that, like the de Bono whistle, more than one attempt may have to be made before a reading can be obtained. The Airflometer[7] is a rather complex instrument in which a turbine is driven round and the peak flow recorded depends on the amount of over-run. Measurements with this device are likely to be affected by friction and workmanship, and the instrument does not seem to measure any definable physical value. The most recent device, the Pulmonary Monitor[8] is similar to the mini-meter but is calibrated in arbitrary units and its mouthpiece is too small to take peak flows from a healthy adult.

The peak expiratory flow rate, as defined by Wright and McKerrow,[1] is now such a well-established clinical and epidemiological measurement that it seems a pity that devices purporting to measure it should be described without adequate consideration of their physical properties and without carefully controlled correlation studies against the standard instrument or some more nearly absolute instrument such as a pneumotachograph. When the original peak-flow meter was being developed it was first calibrated on steady flows, but when used for PEFRs it gave figures that were much higher than those in published reports. The rotating parts were therefore made as light as possible to eliminate overshoot, and tests against a Lilly pneumototachograph showed that the instrument actually underestimated PEFRs by about 17%; allowance was made for this in the instrument's calibration, which was carried out on actual PEFRs.

The commercial version of the instrument was developed by Mr J McNaughton of Clement Clarke, and I am grateful to him for keeping as closely as possible to the original design while making valuable contributions that were necessary for commercial production. I am also grateful to Dr C M Fletcher for making many clinical tests of prototypes and to Mrs M McDermot and her colleagues for organising and carrying out a full laboratory evaluation.

The instrument is the subject of British Patent No 1463814 dated February 1977, the rights in which are vested in the National Research Development Corporation. The instrument is made and marketed by Clement Clarke International Ltd, Airmed House, Edinburgh Way, Harlow, Essex, CM20 2ED, from whom it may be obtained.

References

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What is the risk of brucellosis from drinking goats' milk? Is there any test of goats (or their milk) that is relevant? Are there any other risks in drinking goats' milk?

Brucellosis in Britain may be caused by infection with *Brucella abortus*, which can infect cattle, goats, and sheep, or by *B suis*, which causes brucellosis in pigs. *B melitensis*, which causes Malta fever in Mediterranean countries and the East, is not present in sheep and goats in Britain. There is, however, little risk of getting brucellosis from drinking goats' milk in Britain. The goats' milk can be tested for the organism by the same tests as are applied to cattle—taking a blood or a milk sample, or both, and sending it to the Central Veterinary Laboratory, Weybridge, for testing. The only other risk in drinking goats' milk might be tuberculosis, but this is now unlikely. If the milk is pasteurised (heated to 61°C-63°C for 30 minutes) both brucella and *Mycobacterium tuberculosis* are effectively destroyed.