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An evaluation of the mini-Wright peak flow meter

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ABSTRACT The mini-Wright peak flow meter (MPFM) has been evaluated, and the results obtained from it show a strong positive correlation ($r=0{\cdot}970$) with the Wright's peak flow meter (PFM). MPFM measurements, however, were biased to be about 38 l/min higher than PFM measurements (95% confidence limits 31·0 l/min to 45·0 l/min). Between instrument variation was found (F—ratio 3·67 with 9 and 81 degrees of freedom: $P<0{\cdot}001$). In practice this did not appreciably affect individual measurements greatly as 95% confidence limits on any individual measurements were increased from ±24 l/min to ±27 l/min. There was no significant day-to-day variability in measurements obtained with individual instruments. The MPFM is a pocket-sized, simple, cheap, and robust instrument for following changes in ventilatory function. In clinical trials and surveys, however, both the bias in favour of the MPFM compared to the PFM and inter-machine variation must be taken into account. As the manufacturers have altered the scale to remove the bias since this study was performed, it will be important to know whether the original or the modified meter is being used in future studies.

The increasing use of simple pulmonary function tests in many fields such as occupational medicine (Ward, 1977), clinical drug trials (Robertson *et al*, 1969) and in the continuing care of patients in hospital (Turner-Warwick, 1977) and at home (Haydu *et al*, 1976) has led to the development of small portable instruments. The original instrument was the Wright peak flow meter (PFM) (Wright and McKerrow, 1959), but latterly various smaller and cheaper instruments suitable for domiciliary practice have been developed.

The peak flow gauge (Ferraris Development and Engineering Co Ltd, London N18 3JD, UK) correlates closely with the PFM (Bhoomkar *et al*, 1975) but is too bulky to be carried easily. The pulmonary monitor (Vitalograph Ltd, Maids Moreton House, Buckingham MK18 1SW, UK) is pocket-sized, reliable, and gives reproducible values that correlate well with the PFM (Haydu *et al*, 1976). Unfortunately the monitor has a scale differing from the standard PFM. This would make comparison between trials difficult. Recently a mini-Wright peak flow meter (MPFM) has become available (Airmed, Clement Clarke International Ltd, Airmed House, Edinburgh Way, Harlow, Essex CM20 2ED, UK).

This study was designed to determine the reliability and reproducibility of the MPFM and to compare the measurements obtained with it to the standard PFM.

Patients, materials, and methods

The instrument (fig 1) is a light plastic cylinder measuring 15×5 cm and weighing 72 g (without mouth-piece). It consists of a spring piston that slides freely on a rod within the body of the instrument. The piston drives an independent sliding indicator along a slot marked with a scale graduated from 60 l/min to 800 l/min. The indicator records the maximum movement of the piston, remaining in that position until returned to zero by the operator. In use the machine must be held horizontally with the air vents uncovered.

In the first study the MPFM was compared to the PFM in 100 consecutive patients attending the department. Measurements were taken with the patient sitting upright, and the highest value of three peak expiratory flow rate manoeuvres was recorded. Recovery time between measurements averaged one to two minutes but was longer in the

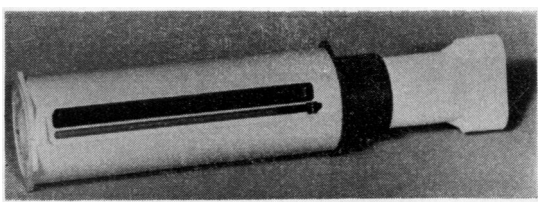

Fig 1 *Mini-Wright peak flow meter.*

more disabled patients. The order of use of instruments was randomised; 56 patients used the PFM first.

In the second study the day-to-day variability of peak flow measurements using two MPFMs was assessed. Daily peak flow recordings were obtained in ten normal subjects over a five-day period using each machine. Each subject used both machines, the order of use being decided on a random basis. Readings were obtained in the same manner as the first study and at the same time each day.

In the third study between-machine differences for the MPFM were assessed. Ten subjects were randomly allocated to each of ten MPFMs. Peak flow measurements were obtained as in the first two parts of the study. On nine subsequent days each subject was randomly allocated to a further meter. Each meter was used only once by each subject. Again, readings were taken at the same time each day.

Part 1 of the study was analysed using paired *t*-test, chi-squared test, and variance-ratio test and parts 2 and 3 by analysis of variance. All machines used were obtained from the manufacturers after March 1978 and without their prior knowledge of the study.

Results

FIRST STUDY

In the comparison of the MPFM to the PFM the 100 pairs of peak flow measurements showed a strong positive correlation ($r=0{\cdot}970$) and the error variation was small relative to real variation. The mean peak flow reading using the MPFM was 368·8 l/min (SD±146·7 l/min) and the PFM 330·9 l/min (SD±147·1 l/min). The mini-Wright peak flow measurements were biased to be about 38 l/min higher than meter measurements throughout the range of measurement covered (95% confidence limits 31·0 l/min to 45·0 l/min) (fig 2).

SECOND STUDY

In the study of day-to-day variability no significant difference was detected between meters, between orders of testing, or between days, and no significant interactions were found. The main source of variability in the results was between patients, which accounted for 96·7% of the observed variation in peak flow measurements.

THIRD STUDY

Results of the analysis of variance showed that there was a significant variation between machines (between machines F—ratio 3·67 with 9 and 81 degrees of freedom: $P<0{\cdot}001$) but this was small in absolute terms. Assuming that no real interaction occurs between subjects and machines, the estimated standard deviation in measurements attributable to error (that is, factors not controlled in the experiment) was 11·88 and the estimated additional standard deviation between machines 6·16. As these are independent the resultant standard deviation for a randomly selected subject on a randomly selected machine was 13·38, not a great increase over the 11·88 obtained purely from error.

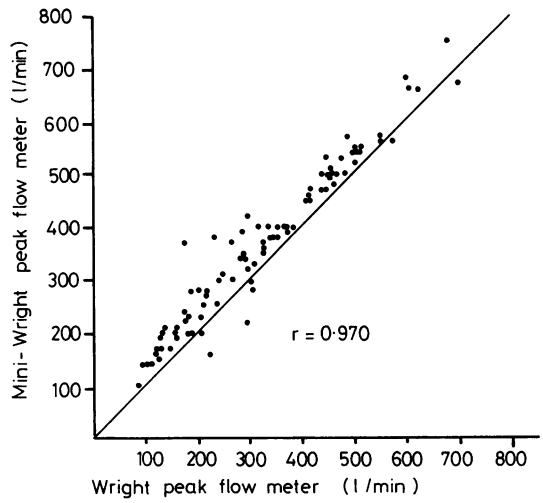

Fig 2 *Comparison of flow meter readings in 100 patients, showing line of identity.*

Discussion

Results show that measurements made by the MPFM differ significantly from measurements made using the PFM, the results varying in favour of the MPFM by 38 l/min throughout the range covered. The percentage bias in favour of the MPFM is therefore greater in patients with airways obstruction than in normal subjects. The measurements show, however, a strong positive correlation, and error variation is small compared to real variation. In addition the study showed significant variation between individual machines. This variation does not greatly affect the accuracy of individual measurements, since 95% confidence limits on any individual measurement are increased from about ±24 l/min to ±27 l/min provided that measurements are made on a random selection of machines. If subjects are studied consistently on the same machine (which will be usual) then consistently high or low measurements may be obtained.

There was no day-to-day variation in the readings obtained with the same MPFM and in this respect it is similar to the pulmonary monitor (Haydu *et al*, 1976), but the former has the advantage of being able to read the peak flow rate directly. Hence both machines are suitable for repeated measurements of peak flow rate at home, hospital, or work. Measurements made on the MPFM may be erroneous if the instrument is not held horizontally or if any of the slots or holes are obscured. Thus it is important that the patient be correctly instructed before an instrument is issued for home use.

In conclusion the findings indicate that the MPFM is a single, cheap, and robust instrument that will be of value in following changes in peak flow rate in patients away from the laboratory. In clinical trials and surveys, however, inter-machine variation and the bias in favour of the MPFM compared to the PFM must be taken into consideration.

Since December 1977 the manufacturers have altered the scale of the MPFM to remove the bias in its favour compared to the PFM. Meters with the old scale, however, can still be obtained from the manufacturers. If the MPFM is used for epidemiological studies care must be taken to ensure that only meters with the corrected scale are obtained.

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