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The performance of Mini Wright peak flow meters after prolonged use

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The accuracy of 84 new and 35 old Mini Wright peak flow meters were tested using a servo-controlled pump system. The 95% confidence limits for flow measurement across the range of the new meters was between ± 15 l min^{-1} at the lower end of the range and ± 28 l min^{-1} at the top of the range. The readings for 22 (63%) of the old meters (age range 1–13 yr) were within these 95% confidence limits. For the remaining 13 old meters (age range 1–13 yr) whose readings were not within these limits, there were 11 meters with readings falling below and two meters with readings above these limits. Twelve of these old meters were washed and retested and there was no significant change in their readings. Twenty of the new meters were retested after 1 yr of continuous use and their readings were significantly higher with a median value of 5 l min^{-1} across the range, although only two of these 20 meters had readings outside the 95% confidence limits set from the 84 new meters. It is concluded that whilst Mini Wright meters aged up to 14 yr can give readings which are as good as new meters, some meters demonstrate significant changes in readings after only 1 yr and washing did not correct this change. It is recommended that clinicians prescribing peak expiratory flow (PEF) meters should be responsible for checking the patient's meter as well as their PEF readings at clinic visits.

Introduction

Peak expiratory flow (PEF) recordings have come to form an integral part of modern asthma diagnosis and management. Self-management plans that allow for changes in treatment to be instigated on observed changes in PEF are being increasingly adopted (1,2). Mini Wright and other PEF meters have recently been shown to be inaccurate with characteristic and consistent error profiles (3,4). However, to date, little data exists on the effects of prolonged use of such meters on these error profiles. The manufacturer's current guidelines for Mini Wright meters recommend replacement of meters after 3-yr usage and encourage regular cleaning by occasional immersion in a warm detergent. This study has determined the error profiles for 35 Mini Wright PEF meters which had been in constant use for over 1 yr and compared these with the results from 84 new meters. The effects of the standard cleaning procedure on the meters' performance was also examined.

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Methods

Error profiles for the Mini Wright PEF meters were determined using a computerized servo-controlled pump system that has previously been described (5). A group of 84 new Mini Wright meters and 35 old meters which had been in constant use for at least 1 yr were tested using the previously described cusp flow profile over a flow range of 60–720 l min^{-1} at 60 l min^{-1} increments. The 95% confidence limits for the readings from the new meters were used to determine which of the old meters were reading differently from the new meters. Twelve of the old PEF meters were then cleaned according to the manufacturer's instructions and retested to determine if there was a change in reading. Twenty of the new meters were given to patients to be used for 1 yr, and were then retested to see if any change had occurred in that time. Statistical comparisons were made using Minitab Version 9.2, with a probability of less than 5% being taken as significant.

Results

The age range for the 35 meters tested was 1–13 yr and the precise age of 23 of the old meters was known with a mean age of 4·8 yr (SD 3·8 yr, median 4 yr).

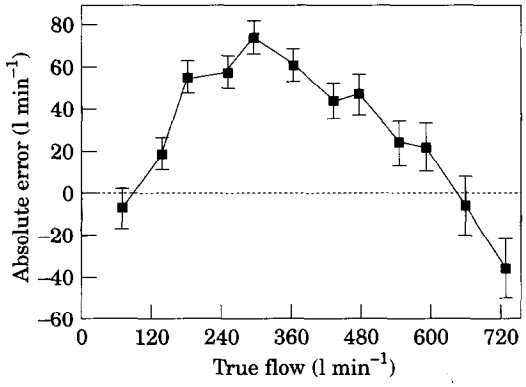

Fig. 1 The mean error in peak expiratory flow reading for 84 new Mini Wright peak flow meters. Bars indicate SD.

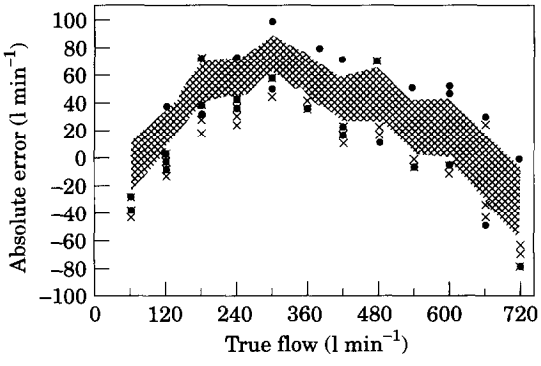

Fig. 2 A plot showing the 95% confidence limits for the flow error in 84 new Mini Wright peak flow meters (hatched area), together with readings from new meters (●) and old meters (×) which were outside these limits.

The error profile for the 84 new meters is shown in Fig. 1 and was the same shape as previously described (3,4). The maximum error was a mean of 73 l min^{-1} (SD 7·6 l min^{-1}) at a true flow of 300 l min^{-1}. The 95% confidence limits for the mean error in flow measurement ranged from ± 15 l min^{-1} in the lower range to ± 28 l min^{-1} at the top of the range. Of the 84 new meters, there were eight meters which had one or more readings outside the 95% confidence limits. The error profiles for the 35 used meters were all of the same shape as seen in Fig. 1 and the results for 13 of these used meters (age range 1–13 yr) were outside the 95% confidence limits set by the 84 new meters, with a general tendency for them to under-read when compared to the new meters. The degree of error in the meters ranged from an under-reading of 80 l min^{-1} at a true flow of 720 l min^{-1} to an over-reading of 100 l min^{-1} at a true flow of 300 l min^{-1}. Figure 2 shows the 95% confidence limits for the error in the new meters and the degree of deviation from this found amongst the new and old meters. Three of the old meters only deviated at one flow in the range, two of the old meters deviated at only two flows, and six of the old meters deviated on more than one-half of the flow points tested, with their readings being as much as 20 l min^{-1} less than the lower 95% confidence limit.

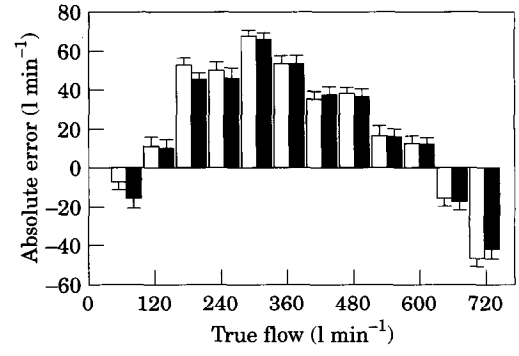

Fig. 3 The mean error in peak expiratory flow reading for 12 old Mini Wright peak flow meters, before and after washing. Bars indicate SE; open columns, unwashed readings; solid columns, washed readings.

The results following washing and cleaning 12 of the old meters are shown in Fig. 3, with no significant change observed in their readings ($P>0·05$, Wilcoxon signed rank test). The 20 new meters that were retested after 1 yr of continuous use had readings, across the range, that were on average 6·6 l min^{-1} higher than when new (median 5 l min^{-1} higher, $P<0·001$ Wilcoxon signed rank test). Only two of these 20 meters had any readings outside the 95% confidence limits set by the 84 new meters.

Discussion

Home monitoring of peak expiratory flow is now well established as a means for improving asthma morbidity (1,2), and it has long been recognized that home peak flow readings are a reliable means for assessing asthma control (6). This study has shown that peak flow meters are sturdy instruments with acceptable readings being achievable from meters that are over 10 yr of age. However, the performance of some meters which were aged less than 2 yr was significantly different from that of new meters. The magnitude of this difference in reading when compared to new meters was not of a sufficient degree to distort the PEF record, but trigger values of PEF used in self-management plans (1,2) may be reached more frequently when using one of the old meters.

This study has not accounted for any difference in meter performance due to batch differences that could have occurred. The manufacturer maintains very careful quality controls to ensure that PEF meters adhere as closely as possible in response to a master standard Wright meter. The 84 new meters tested were not all from the same batch and so the confidence limits presented here include any minor variation in manufacture. It seems much more likely that the changes in used meters found in this study relate to changes in the meters brought on by excessive and/or incorrect use over the years. If the meters are allowed to get dirty, the movement of the internal baffle or the pointer on the scale could be impeded. However, none of the meters studied showed signs of contamination and cleaning did not change their readings. These meters can be damaged by mis-use and although they are thermally stable at normal working ambient temperatures, extremes such as very hot water or being left too close to a fire could change the dimensions of the meter and influence their readings. For cleaning purposes, Mini Wright meters can be taken apart, but they may then be at their most vulnerable to damage since small changes to the baffle or deliberately stretching the spring can permanently damage the meter and alter its readings. The advantages of cleaning such meters may not outweigh the risks of damaging them during the process, however, these meters can become colonized with fungus if they are not cared for properly (7).

With respect to recommendations about replacement of meters every 3 yr, this study suggests that these guidelines may need review. Peak flow meters are relatively inexpensive when compared to systems for the home monitoring of diabetes mellitus or when compared to the treatment costs of asthma. Whilst in the authors' experience, meters are able to give reliable service for over 10 yr, they may become defective after a much shorter time. This may largely depend on the level of care the subject gives to their meter. None of the meters tested in this study had any obvious, visible defect or damage. Regular testing of meters for their accuracy could potentially identify those that need replacing but this would be a very large and complex undertaking which cannot be justified at the present time.

The authors recommend that practitioners who are prescribing peak flow meters must take responsibility not only for checking the patient's ability to record their peak flow accurately but also for checking that they care for their meter correctly. When such patients are reviewed, the PEF meter should be inspected as well as the PEF record. Attention should be paid to look for any cracks in the meter's plastic or any obvious deformity in the shape. The pointer should be able to move smoothly along the scale and the meter should be gently shaken to check for loose foreign bodies inside. If after a simple inspection of the meter there are reasons to suspect that it may be defective, then the meter should be replaced. In addition, if either the patient or clinician has reason to doubt the validity of the readings obtained then the meter should be changed. In the absence of these conditions, it seems reasonable for meters to be used for longer than 3 yr in selected patients.

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