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TECHNICAL NOTE

Are we recording peak flows properly in young children?

A. Greenough, L. Everett, J.F. Price

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ABSTRACT: Peak flow rate is used in young children to assess bronchodilator response and monitor asthma status at home. Frequently the best of only three peak flow manoeuvres is reported. The aim of this study was to assess if this was sufficient to give the maximum peak flow rate and to determine the reproducibility of the measurement. Thirty nine children aged between three and ten years were recruited. Peak expiratory flow rate (PEFR) was measured six times in each child at two minute intervals. Less than half (13 of 39) of the children made their maximum blow in the first three manoeuvres. The maximum peak flow from the second set of three blows was a median of 7% greater than that from the first three blows. The coefficient of variation of the measurement was 8.8% suggesting a change in PEFR greater than 17.6 % is necessary to demonstrate a response to bronchodilator. We conclude three peak flow manoeuvres are insufficient in the majority of young children to demonstrate the maximum peak flow.

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Peak flow has been used in young children to assess bronchodilator response and confirm reversibility. Its main advantage is its simplicity, which means that the test can be performed repeatedly and at home. Although children as young as two years can perform a peak flow manoeuvre they require practice and some tend initially to close their glottis [1]. Despite this, in many asthma trials in which morning and evening peak flows are recorded at home, the best of only three peak manoeuvres is reported [2–6]. The aim of this study was to assess if this gave the maximum peak flow. We also hoped to establish the reproducibility of the measurement and thus determine the change in peak flow necessary to demonstrate a response to bronchodilator therapy.

Methods

Thirty nine children with well controlled asthma aged between 2.5 and 10 yrs (mean age 6.0 yrs, SD 2.7 yrs) were recruited. The children were all familiar with performing the peak flow manoeuvre and thus were asked immediately to perform six test blows each separated by two minutes. The children were all supervised by a technician (LE) who was unaware of any hypothesis which related the maximum peak flow to a particular number of peak flow manoeuvres. Peak flow was recorded in the standing position and all children were studied in the morning. A single Wright's peak flow meter was used throughout the study. All consecutive manoeuvres were recorded. As patient co-operation is limited, it is standard practice in children to report consecutive peak flow manoeuvres [2–6] and not accept only those within a defined proportion of one another. From the six consecutive manoeuvres the timing of the maximum peak expiratory flow rate (PEFR) was noted.

Ten of the 39 children were asked to perform 6 additional manoeuvres (again 2 min apart) after a period of 20 min, the maximum peak flow of this second set of 6 was noted. The two maximum peak flows were then compared. The coefficient of variation of the measurement was calculated by determining the difference between these two maximum peak flows in each of the ten children.

Statistical analysis

Differences between children who performed their maximum peak expiratory flow rate in the first or second set of blows were assessed for statistical significance using the Wilcoxon rank sum test.

Results

One child, despite previous familiarity with the peak flow manoeuvre, refused to make more than two blows. All of the other 38 children made six consecutive peak flow manoeuvres. Only thirteen children made their

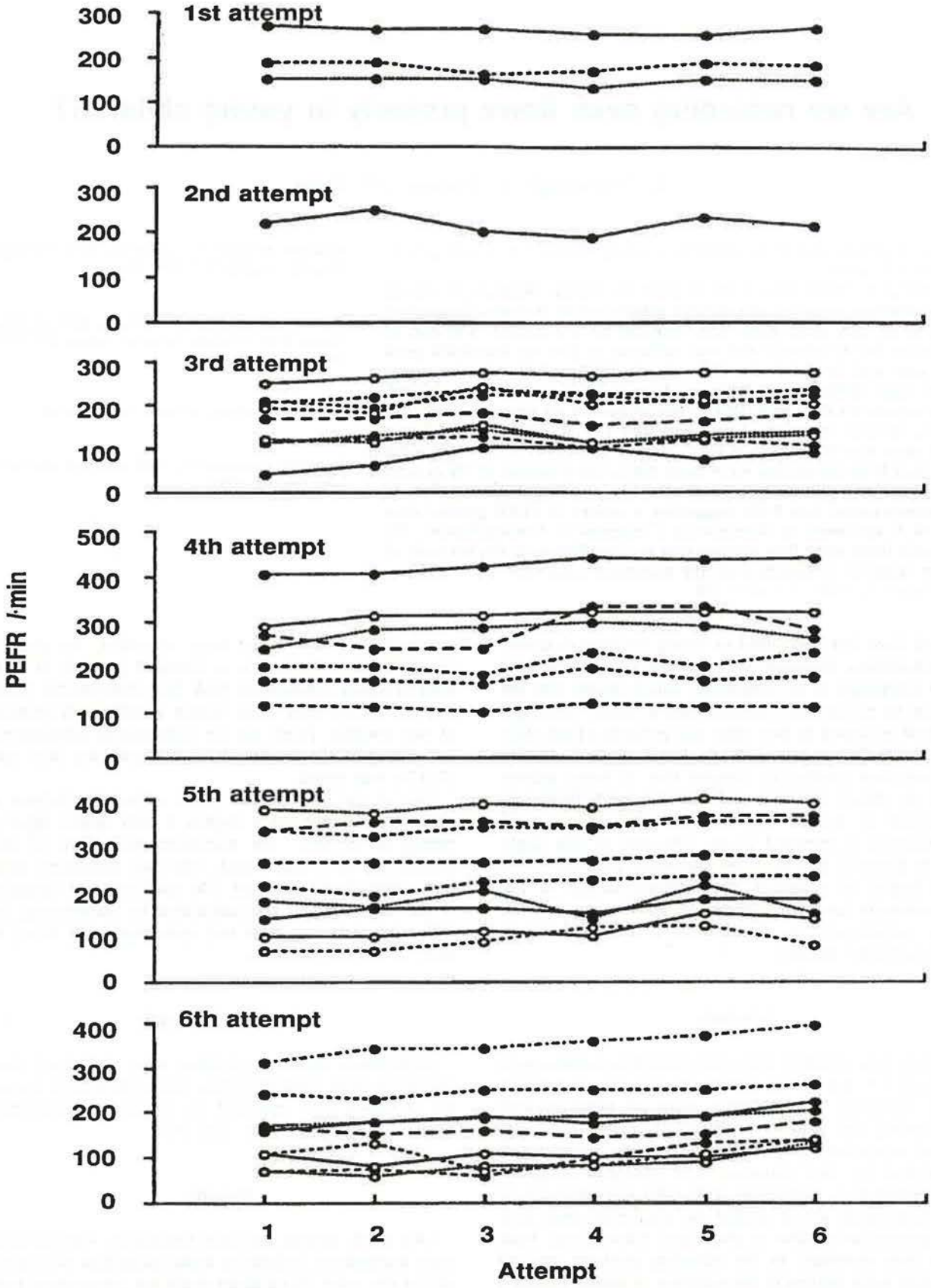

Fig. 1. – Peak expiratory flow rate (PEFR) on each attempt is shown for individual children:. The data are divided into six according to the position of the blow by which the children achieved their maximum PEFR.

maximum peak flow in the first three manoeuvres and 24 in the last 3: 3 on first, 1 on second, 9 on third, 7 on the fourth, 9 on the fifth and 8 on the sixth. In the latter 24 children the maximum peak flow from the second set of 3 blows was a median of 10% (range 2.8–87.5%) greater than the maximum peak flow from the first set of blows. In the 38 children the maximum peak flow from the second set of three blows was a median of 7% (range -18 to 87.5%) greater than the maximum from the first set of blows. The younger children were more likely to blow their maximum PEFR in the second set of three blows, median age 6 yrs (range 2.5–10 yrs) whereas the older children tended to blow their maximum PEFR in the first set, median age 8 yrs (range 6–10 yrs), ($p<0.01$).

The coefficient of variation of the measurement was determined from the 10 children to be 8.8%. Thus, a clinically significant change would be demonstrated by a change in peak flow of greater than 17.6%. Five children consistently made their maximum manoeuvre in the second set of blows and one in the first set. Of the remaining four children no consistent pattern was seen. Only two children made the maximum PEFR on the same blow on each run, one on the first and the other on the fifth blow.

Discussion

Traditionally peak expiratory flow rate is reported as the maximum of 3 attempts [2–7]. One study [8] in normal children has suggested that six successive readings of peak flow should be made. Using this technique [8] the maximum PEFR varied by as much as 5% from the average of 3 recordings, suggesting more than 3 PEFRs should be attempted. The results of the present study demonstrate that in the majority of young children 3 manoeuvres are insufficient to demonstrate maximum peak flow, less than half having their maximum peak flow in the first three manoeuvres. The children included in this study were relatively young but only one failed to comply with six peak flow manoeuvres, suggesting that it is feasible to ask children to make this number of manoeuvres.

The peak flow manoeuvre is influenced by the patient's skill. In this study only asthmatic children, who were well used to this technique, were recruited, thus inexperience did not influence our results. It is unlikely that fatigue explained our results as we waited two minutes between manoeuvres, even though others [7] have suggested 30 s may be sufficient. As the majority of children performed their maximum PEFR in the second set of three blows, this is further evidence against fatigue influencing our results, as this would be more likely to impair the results of the second rather than the first set of blows. In adults, forced vital capacity manoeuvres, if repeated, can be associated with bronchoconstriction, thus it seems unlikely that the repeated forced expiratory manoeuvres in children caused bronchodilation, and this has certainly not previously been documented. Peak expiratory flow rate is effort-dependent and thus a likely explanation for our results is that, despite our patients' experience with the flow manoeuvre, they learned to increase the effort they made with each blow. This explanation is supported by our finding that the children making their maximum PEFR in the second set of blows were significantly younger than those making their maximum PEFR in the first set. Thus, the younger children required more blows to practise making their maximum effort.

It is extremely important to assess the precision and reproducibility of any measurement that is to be used as a screening test or to be used as part of long-term follow-up [9]. In asthmatics it is important to be able to monitor their progress and accurately determine their bronchodilator response. A change which reflects an improvement in clinical state must be one that exceeds the intrasubject variability of the measurement. One study has shown that such a change in PEFR in adults has to be as large as 16.6% [9]. Our data suggest that a similar change in peak flow (17.6%) is necessary to confirm a bronchodilator response in children. In adults, forced expiratory volume in one second (FEV_1) is highly reproducible, only a change of 8.8% is necessary to detect a bronchodilator effect. Unfortunately, in young children FEV_1 often cannot be measured.

A previous study attempted to assess the reproducibility of the measurement in healthy children [10]. Using the maximum PEFR, a coefficient of variation of 7.8% was calculated from 4 children on 4 separate occasions and 3 children on 3 separate occasions. In the present study a similar coefficient of variation (8.8%) was demonstrated, but for asthmatic children. The children included in our study were well controlled and were asymptomatic at the time of measurement. Amongst normal subjects there is a variation in peak flow of up to 8.3% during the course of serial measurements throughout the day [7]: all our patients were measured at the same time of the day.

Measurement of respiratory function in the pre-school child is difficult because of limited patient co-operation, yet the children are too old to be sedated. It has recently been reported that measurement of functional residual capacity by helium gas dilution is well-tolerated in this age group and is associated with a coefficient of variation of only 4%, even in asthmatic children [11]. Although this measurement would thus be the more sensitive test of bronchodilator reponsiveness, its use must be restricted to hospital use because of bulky and expensive equipment. Measurement of peak flow remains the only measurement that can be easily made within the young child's home. Our results demonstrate that to obtain the most accurate information from this test we must modify our instructions on perfomance of the technique.

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Enregistrons-nous correctement les débits de pointe chez les petits enfants? A. Greenough, L. Everett, J.F. Price.
RÉSUMÉ: Le débit expiratoire de pointe est utilisé chez les jeunes enfants pour apprécier la réponse bronchodilatatrice ainsi que pour suivre l'état asthmatique du domicile. Fréquemment, l'on note le résultat le meilleur de seulement trois manoeuvres de débit de pointe. Le but de cette étude était d'apprécier si ceci suffisait pour obtenir le débit de pointe maximum et pour déterminer la reproductibilié de la mesure. Trente-neuf enfants âgés de 3 à 10 ans ont été recrutés. Le débit expiratoire de pointe a été mesuré à six reprises chez chaque enfant à des intervalles de deux minutes. Moins de la moitié (13 de 39) des enfants ont obtenu un débit maximum au cours des trois premières manoeuvres. Le débit maximum de pointe obtenu au cours de la deuxième série de trois mesures a une valeur médiane de 7% supérieure à celui des trois premières mesures. Le coefficient de variation de la mesure est de 8.8%, suggérant qu'une modification du débit de pointe supérieure à 17.6% est indispensable pour démontrer la réponse à un bronchodilatateur. Nous concluons que l'emploi de trois mesures du débit de pointe est insuffisant chez la majorité des jeunes enfants pour obtenir le débit expiratoire de pointe maximum.
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