Peak Flow Meter Characteristics and Asthma.

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Citation

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Abstract

Asthma is an episodic disease characterized by acute airway narrowing in at least two common scenarios. The first is when an irritant such as cigarette smoke, fumes from an industrial source, strong perfume, or even exercise cause an acute bronchospastic event. This type of asthma usually reverses with bronchodilator therapy in the first 2 hours with little subsequent airway inflammation and recovery of peak flows back to the normal range. The only other treatment may be avoidance of the irritant if possible. In a second type of clinical situation, an asthmatic develops ongoing airway inflammation due to daily pollen exposure, chronic cockroach exposure in the household, or other chronic condition causing airway irritation resulting in progressive inflammation and eventual bronchospasm poorly relieved by bronchodilators alone. These patients do not normalize peak flow immediately and require systemic steroids either as an inpatient or outpatient. Normalization of peak flow may occur in 3-4 days or may take up to several weeks of systemic steroids. In both cases, monitoring of airway caliber is done with a peak flow meter.

INTRODUCTION

Asthma is an episodic disease characterized by acute airway narrowing in at least two common scenarios. The first is when an irritant such as cigarette smoke, fumes from an industrial source, strong perfume, or even exercise cause an acute bronchospastic event. This type of asthma usually reverses with bronchodilator therapy in the first 2 hours with little subsequent airway inflammation and recovery of peak flows back to the normal range. The only other treatment may be avoidance of the irritant if possible. In a second type of clinical situation, an asthmatic develops ongoing airway inflammation due to daily pollen exposure, chronic cockroach exposure in the household, or other chronic condition causing airway irritation resulting in progressive inflammation and eventual bronchospasm poorly relieved by bronchodilators alone. These patients do not normalize peak flow immediately and require systemic steroids either as an inpatient or outpatient. Normalization of peak flow may occur in 3-4 days or may take up to several weeks of systemic steroids. In both cases, monitoring of airway caliber is done with a peak flow meter.

The peak flow meter, developed by Martin Wright in 1959 (1), has been used to monitor serial lung function in asthmatics because it is inexpensive, portable, easy to use, and it is an objective measure of lung function. In addition, patients can be taught to use the meter and monitor their own lung function to determine when to use different medication as guided by an asthma action plan. The only weakness of the peak flow meter as with most pulmonary function measures is that it does require patient co-operation and effort.

PEAK FLOW METER PRECISION AND ACUTE ASTHMA

In an asthma exacerbation, the primary requirement for a peak flow meter is precision (reproducibility). As long as the meter is precise, both the patient and health care provider can rely on the numbers to determine whether airway caliber is improving or getting worse with treatment. All that is needed is a baseline peak flow to start with and some type of treatment. Then, serial peak flows can objectively determine whether or not an asthmatic is improving. High precision guarantees to both the patient and health care provider (without them consciously realizing it) that the serial changes seen are due to the patients changing condition and “not” due to instrument variability.

Along these lines it has clearly been shown that a number of peak flow meters are extremely precise with only about a 3% variability (2, 3). In particular, the Wright and Mini Wright peak flow meters appear to easily distinguish 5% variation in peak flow across the spectrum of machine flows measured from 126 liters/min and higher (2). Both Wright and Mini

Wright peak flow meters were also the most precise relative to other peak flow meters at low peak flows (2). Fortunately, this is the case since the Wright or Mini Wright peak flow meters were often used in the past as the criterion standard to compare new peak flow meters as they appeared on the market. This occurred since the Wright peak flow meters were developed first (1, 4).

In contrast to machine derived peak flow meter reproducibility, a study has evaluated human peak flow reproducibility using a Mini Wright peak flow meter in 75 healthy subjects and 35 patients with either asthma or COPD (5). It was found that 76% of all subjects could reproduce their peak flow within 30 liter/min using a pneumotachometer and 88% could reproduce their peak flow within 30 liters/min when the pneumotachometer was placed in series with the Mini Wright peak flow meter (5). Unfortunately, no studies looked at peak flow reproducibility using the Mini Wright peak flow meter alone. In addition, a consensus conference on lung function accepts a peak flow reproducibility within 40 liters/min or less between two values as a reasonable goal to strive for (6). The consensus conference states that 95% of untrained subjects can attain this reproducibility, albeit it is unclear where the data supporting this value comes from (6). Using 500 liters/min as a random peak flow value picked out of the air, using this criteria would yield a precision of 40/500 or 8% reproducibility, a believable value in human studies.

PEAK FLOW METER ACCURACY AND CHRONIC ASTHMA

The Mini Wright peak flow meter currently recommended for use in the U.S. is the ATS Mini Wright peak flow meter. It can be identified by its scale which has white text on a purple background with the words ATS 94 written on the scale. It is an improved version from the original Mini Wright meter (4) which tended to over-read values in the peak flow range from 200 to 550 liters/min (3, 7). The ATS version is the same mechanical device as the traditional Mini Wright meter except that the scale was changed on the meter to more accurately reflect actual peak flows (2,7). In order to determine more accurate peak flows and adjust the scale, test peak flows were generated by a wave form generator with the peak flow technique (7,8). Then the old Mini Wright scale was changed to the new more accurate white text on a purple background. In addition, the explosive flow profiles that occur when patients do their peak flows are still accurately measured when using the Mini Wright peak flow meter, which is not the case with all peak flow meters (9). Currently, the ATS Mini Wright peak flow meter is accurate to the recommended 10% or 20 liters/min, whichever is greater (6).

When asthmatics are seen on follow-up in the office or clinic one of the determinants of the severity of their asthma is the peak flow at the time of the visit as compared with their predicted peak flow (10). If the peak flow is inaccurate as was seen with the Mini Wright peak flow meter before the scale was improved, this can result in significant under treatment of asthma (11) and undoubtedly increased morbidity. In addition, many of the more severe chronic asthmatics complain of minimal symptoms but have severe reductions in lung function (12,13). Not only do peak flows need to be determined on such patients since they will claim to feel better than actual peak flow will indicate, but accurate values will then allow physicians to classify and treat such patients according to current NIH guidelines (14).

SUMMARY

The ATS Mini Wright peak flow meter can reliably detect changes in peak flow of at least 5% since the precision is about 3% using machine peak flows (2). This precision is much less adding the human dimension and may be more around 8% as a guesstimate as noted above. This would translate into a peak flow change from 150 to 165 liters/min as being a real change and not due to the variability of the meter. The accuracy of the Mini Wright meter is felt to be within 10% of the true value or 20 liters/min (whichever is greater), implying that a peak flow measurement of 200 liters/min could be anywhere from 180 to 220 liters/min as the true value. Peak flow precision is needed to follow trends during an acute asthma exacerbation to help determine whether a patient is improving or getting worse. Peak flow accuracy is needed to help classify stable asthmatics according to current NIH guidelines (14) so appropriate long term therapy can be delivered. In addition, accuracy is desirable after ED treatment of the acute asthma exacerbation to determine whether to hospitalize or not. In general peak flow values of 40% predicted or less require hospitalization and even higher predicted values often require hospitalization of the sick asthmatic depending on circumstances (14).

One of the better peak flow meters is the ATS Mini Wright peak flow meter. It delivers on both precision and accuracy. Although the manufacturer recommends replacement after about 3 years of use, some Mini Wright meters have performed well for up to 14 years (15). Therefore, the total

use per year is probably more important than the total years of use.

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