



Peak Flow and its role in Asthma Management A Summary for Healthcare Professionals – Fall 2004

Peak Expiratory Flow (PEF) is the simplest pulmonary function test - it is defined as the maximum flow generated during expiration, when performed with maximal force and started after a full inspiration. The test can be undertaken in both the Doctor's office, and at home or at school; its value comes from being a simple, objective, and repeatable way of tracking the severity of asthma in adults and children over 5 years of age.

Measurements of PEF can be used to:

- determine the severity of asthma (especially during an acute attack)
- check the response to treatment
- monitor response to treatment in chronic asthma
- warn of worsening lung function in the absence of discernible symptoms
- identify asthma triggers and diagnose exercise-induced asthma
- provide markers for specific actions in a "Self-Management Plan"

"A peak flow meter for a patient with asthma is like a thermometer for a patient with a fever. Peak flow meters help to determine how open your airways are, rather than guessing just how you "feel."

(Patient explanation, from the American Academy of Allergy, Asthma and Immunology)

Who should use a peak flow meter, and why ?

Adults and children (over 5 years of age) who require medication for asthma on a daily or near-daily basis are the group who should be using a peak flow meter regularly. Additionally, there are some patients with COPD and bronchitis who also benefit from this method of monitoring lung function – both groups can use the changes in PEF readings to help reveal how their lungs are functioning, and how well they are responding to treatment.

Whilst most patients soon learn from their Physician that asthma is a disease where the airways constrict and prevent free movement when breathing in and out, many who are taught to use a peak flow meter gain further insight into their disease, and how it can be managed successfully.

From regular use of a peak flow meter, patients will note that not only do the times when they have most difficulty breathing coincide with the lowest PEF reading, but also that PEF readings will have been reducing for a period of time before their asthma attack. Those patients using PEF meters frequently report that they noted deterioration in the time preceding emergency intervention. This "warning" is put to best use when included in specific Asthma or Self-Management Plans, of the type much advocated by pulmonary specialists.

Preventing visits to the Emergency Room, or providing a reference for when to use a reliever medication, through to helping to identify specific asthma triggers at work and home – the peak flow meter has a valuable role when the disease is preventing the individual from getting on with their life.

But it also can help confirm how quality intervention, through proper treatment and use of specific medications, can make an impact – a PEF diary that shows steady PEF readings is proof that the patient is benefiting, provides a guide as to when certain treatments may no longer be needed.

Mini-Wright™
PEAK FLOW METER





Is peak flow monitoring recommended in National guidelines ?

Yes. Both as an aid to diagnosis and management, the National Asthma Education and Prevention Program has commented on the value of peak expiratory flow measurements. Variation of PEF readings above 20% (between morning and afternoon, or pre and post short-acting beta2-agonist) is a key indicator for diagnosis of asthma, and the Expert Panel Review has recommended PEF monitoring in specific patient groups:

NAEPP EPR-2 1997 – “The Panel recommends that patients, especially those with moderate-to-severe persistent asthma or a history of severe exacerbations, be given a written action plan based on signs and symptoms and/or peak expiratory flow. As in the 1991 report, daily peak flow monitoring is recommended for patients with moderate-to-severe persistent asthma. In addition, the Panel states that any patient who develops severe exacerbations may benefit from peak flow monitoring. “

NAEPP EPR-2 Update 2002 - “The NAEPP EPR-2 recommendations have not been changed. It is the opinion of the Expert Panel that peak flow monitoring for patients with moderate or severe persistent asthma should be considered because it may enhance clinician-patient communication and may increase patient and caregiver awareness of the disease status and control.”

What are the benefits of PEF monitoring ?

Encouraging the asthmatic to use a PEF meter can be of high value to the following groups:

Adult patient

Patients can benefit from using a peak flow meter in several ways: to recognize that asthma may be occurring at night, to improve perception of asthma, to identify factors that worsen asthma, and to predict worsening of asthma.

Patients with moderate to severe persistent asthma or unstable asthma are more likely to benefit from long-term daily peak flow monitoring. For example, the Grampian study authors conducted an observational study of 89 patients disqualified from the original study because their asthma was too severe and found that those who used peak flow meters took oral corticosteroids more often (action plan told patients to take oral corticosteroids at specific PEF levels) and had significantly fewer days of limited activity than those who did not use a peak flow meter.

“When asthma is severe enough to have required an A&E visit, stepped care triggered by peak flow measurements reduces re-visits to A&E over the next 6 months.”

Cowie RL, Revitt SG, Underwood MF, Field SK: The effect of a peak flow-based action plan in the prevention of exacerbations of asthma. Chest 1997;112:1534-8.

Child and Parent

In an observational study of children attending a community clinic, 70 percent of the parents of children using peak flow monitoring reported it to be very useful, especially for judging the severity of an exacerbation and the child's response to inhaled short-acting beta₂-agonist (Lloyd and Ali 1992).

Physician

Short-term daily peak flow monitoring is helpful for assessing the severity of a patient's asthma and evaluating response to chronic maintenance therapy.

ER Team

From 5 to 10 percent of patients have severe disease that does not respond to typical therapeutic interventions. To prevent life-threatening sequelae, it is important to identify patients with severe asthma who will require aggressive



management of exacerbations. Objective monitoring of pulmonary status using a peak flow meter is essential in patients with persistent asthma. (Higgins, *Am Fam Physician*. 2004 Mar 1;69(5):1045-6.)

The largest portion of the cost for asthma healthcare is due to hospitalisations, and PEF monitoring has been shown to help reduce re-admission rates. (Castro, *American Journal of Respiratory and Critical Care Medicine* Vol 168. pp. 1095-1099, (2003))

Healthcare providers

The biggest impact of using PEF monitoring may well be in its value as part of the written self-management plan. A recent review for the Cochrane Library included 36 trials comparing self-management education with usual care - This review suggested that self-management education could be associated with a reduction in hospital admissions of up to 40%, a reduction in emergency room visits of 20%, and similarly impressive reductions in unscheduled visits to the doctor, night time symptoms, and days off work or school. (Partridge M R, *Thorax* 2004;59:87-88).

“When patients become coequal with care providers in controlling care, making decisions, and treating themselves with coaching, outcomes improve, costs fall, satisfaction rises, and even physiological measures look better.”

Donald M. Berwick, M.D., M.P.P.,
President and CEO, Institute for Healthcare Improvement; Professor of Health Care Policy and Pediatrics, Harvard Medical School

As a further example, Medicaid costs dropped 37.4 percent for asthma patients in a National Jewish pilot disease management program. The study, sponsored by the Colorado Department of Health Care Policy and Financing, achieved a Return on Investment of 3.15, saving \$202,991.00 during the six-month study of 258 asthmatics - most had mild or moderate asthma, but 24 percent were considered severe. More than three quarters were children under 17.

A word of caution – despite clear recommendations, widespread availability, and relatively low cost, the use of peak flow meters remains poor. In a survey by the Area Health Education Centers Program, Oregon Health Sciences University, Portland, only 24 (44%) of the 54 respondents with moderate to severe asthma had a PEF meter. The authors concluded that physician prescription compliance of peak flow meters for asthma monitoring fell short of the NIH guidelines. (Mendenhall: *Ann Allergy Asthma Immunol*. 2000 May; 84(5): 523-7.)

Who else recommends using a PEF meter ?

Leading Institutions, top Hospitals, and their Physicians, follow the NIH/NHLBI/NAEPP recommendations:

“ Sometimes peak flow numbers will decrease hours, or even a day or two, before other asthma symptoms become evident. When you monitor peak flow numbers on a daily (or regular) basis, you can identify this drop and take steps to prevent an asthma episode. The peak flow numbers, along with watching for asthma symptoms can be used to make decisions about asthma treatment.”

Dr. David Tinkelman, M.D., National Jewish Medical and Research Center

“ One of the most important functions of the peak flow meter is to help the patient and doctor evaluate the severity of asthma. Falling peak flow readings before the symptoms of asthma are otherwise noticed will indicate that an adjustment is needed. This early warning sign could mean adding a medication or making other changes in the treatment plan. The earlier the warning sign and the sooner the problem is corrected, the less medication and the less time it should take to get the lungs back to normal. “

Charles H. Booras, M.D., P.A., Editor, Jacksonville Medical Park Online



“ My personal view is that PEF monitoring in asthma is of most value in those patients who are unsure about when their asthma is worsening or seem to be oblivious to increasing asthma symptoms. The PEF measurements give them a simple number that can quantify whether their asthma may be worsening (or not).”

Dr. Burton Zweiman, AADMC Medical Editor, *American Academy of Allergy, Asthma and Immunology*

“ Recording your peak flow over time helps you: Identify specific asthma triggers, detect subtle changes that may signal obstruction of your airways, so you can intervene before you experience signs and symptoms of an asthma attack, evaluate your course of therapy to make sure it's effective [and] determine when emergency care is needed.”

Web pages for patients, by Mayo Clinic Staff, *Mayo Foundation for Medical Education and Research*

“ The doctor, too, may recommend that you start using a peak flow meter at home. Ask your doctor about this. In peak flow monitoring, you blow into a device, called a peak flow meter, which measures the greatest amount of air that you can exhale.

Peak flow meters are easy to use by yourself every day. These devices can help you to know if your breathing problems are starting even when you don't feel any asthma symptoms. That way, you know when to take your asthma medicine before your symptoms get worse.”

Web pages for patients - Asthma: You & Your Doctor, *American Lung Association*

“ PEF monitoring can be a useful clinical assessment tool, especially for asthmatic patients with moderate-to-severe persistent asthma. Linking the PEF measurements to specific asthma self-management plans with appropriate actions and feedback will enhance its effectiveness and usefulness as a monitoring tool.”

Susan Janson, DNSc, RN, *American College of Chest Physicians*

“ Peak flow meters should be used regularly to check how well the asthma is being controlled. In addition, the peak flow meter may be a valuable tool during an asthma attack, because it can help determine how well the short-term, quick-relief asthma medication is working. “

Web pages for patients, UAB Health System, *University of Alabama at Birmingham*.

“ [PEF meters] can help you decide if your child is well enough to go to school or play sports. When you are not with your child, it can help a grandparent, school nurse or babysitter tell you about your child's asthma. “

Peak Flow Meter Information, *Phoenix Children's Hospital, Arizona*

Why don't more people use them ?

It is not fully known – it may be that not enough healthcare professionals fully understood how the simple peak flow meter can best be used, and have consigned it to a role for one-off measurements when the asthmatic comes to the physician's office. Perhaps the \$20 to \$30 cost of the instrument may seem like a lot of money for something that just tells you how well you are, and many asthmatics and their physicians may not want to spend more money - especially when medications costs (the “inhalers” and “spacers” that people need to get the medication into the lungs) are increasingly high.

Mini-Wright Standard Range
and Low Range peak flow meters



How do you use a peak flow meter correctly ?

Correct technique is not difficult for most patients, and benefits from a little practice and encouragement from the professional or parent – use the following guide to help get the best possible measurements:

Step 1: Before each use, gently reset the sliding marker or pointer on the Peak Flow Meter to the bottom of the numbered scale, closest to the mouthpiece.

Step 2: Remove gum or any food from the mouth, stand up straight, and holding the meter lightly (so as not to obstruct the slot in which the pointer slides), take as deep a breath as possible. Then place the mouthpiece of the Peak Flow Meter into the mouth; close the lips tightly around the mouthpiece, and in one breath blow out as hard and as quickly as possible. Ensure the tongue is kept away from the mouthpiece. The correct method is a quick, hard blow, rather than a long slow exhalation.

Step 3: The pointer will slide up the slot, stopping at a number corresponding to the Peak Expiratory Flow (PEF) for that test. Note the number on a piece of paper.

Step 4: Repeat the entire routine three times (the routine has been done correctly when PEF readings from all three tries are similar). Some patients may wish to rest for a few minutes between trials.

Step 5: Record the highest of the three ratings. Do not calculate an average.

Step 6: Measure Peak Flow Rate close to the same time each day. You should decide the best times in conjunction with your patients. One suggestion is to measure Peak Flow Rate twice daily between 7 and 9 a.m. and between 6 and 8 p.m.

You may want patients to measure Peak Flow Rate before or after using any medicine, but whatever you or your patients choose, encourage them to do it the same way each time.

Step 7: Recommend that patients keep a chart of Peak Flow Rates. Encourage patients to discuss their readings whenever they see you or your colleagues.

How should PEF readings be recorded ?

Chart the highest of the three readings. The chart could include the date at the top of the page with AM and PM listed. The left margin could list a scale, starting with zero (0) liters per minute (L/min) at the bottom of the page and ending with 700 L/min at the top. Sample charts are included in all Mini-Wright and AirZone peak flow meters, and electronic templates can be downloaded from the Web (see www.clement-clarke.com).





What type of peak flow meters can be used ?



The original peak flow meter was developed in the 1950's by Dr. B.M. Wright in England, and was a heavy metal instrument that converted the airflow through it into a reading on a scale. Subsequently, engineers developed the "mini-Wright" portable meter made of medical grade plastics, that has remained the design on which so many other brands of meter have been based. With microelectronics and miniaturisation, it has even been possible to make low cost digital peak flow meters – but no matter how the meter works, the value of PEF readings will still depend on



1. The accuracy of the meter
2. How easy the device is to use
3. Correct technique
4. Recommendation and encouragement from the patient's Physician and other Health Professionals

Some Peak Flow Meters are available in two versions - Teenagers and adults have large airways and will need a large range, but children and those with severe asthma may benefit from the smaller range (called a "low range" meter).



What are the risks of Cross-infection when using Pulmonary Function equipment



As with other equipment, higher risk will be associated with use of a single instrument on multiple patients. As the Mini-Wright was designed for multiple patient use (it features an internal check-valve to prevent inhalation through the meter), it provides additional protection over most other types of PEF meter. Standard cardboard disposable mouthpieces are for single patient use, but the recent introduction of low cost one-way mouthpieces offers a straightforward solution to PEF meter use in Clinic and Hospitals, preventing patients from inhaling through any peak flow meter used.

How accurate are the different peak flow meters ?

PEF meters used in the US should conform to recommendations set by the American Thoracic Society (Standardization of Spirometry, 1994 Update). Some designs of PEF meters available in the US are also able to meet the more stringent test criteria required for medical use in Australia and New Zealand, and Europe.

International experts on peak flow measurement have used the original US standards to develop new testing methods - with the aim of identifying PEF meters that could give incorrect readings if patients blow into them in a certain way.





Recent research published in Thorax warns that two commonly used PEF meters provide higher than expected PEF readings for certain types of patients – with a risk that management plans may be compromised for these patients.

The readings for the *TrueZone* and *MultiSpiro* PEF meters indicated that these meters are very markedly underdamped — that is, the reading considerably overshoots with a brief impulse of flow.

(Miller et al, Thorax 2003;58:411–416)

The researchers commented that for flow to be recorded accurately from a maximal forced expiratory maneuver it is essential that the recording device has adequate dynamic response characteristics, as well as being linear and accurate over its operational range (Miller et al Thorax 2003; 58:411–416).

The development of tighter standards for PEF meters (such as the new European Standard, EN 13826) follows work by other research teams that found unacceptable errors in accuracy at various flows, when tested on an American Thoracic Society test rig:

Accuracy of ATS Scale PEF Meters at 9 different test flows (l/min)
25 instruments measured 3 times each

	98	148	198	246	295	344	369	491	700
Vitalograph	-5.1%	-5.0%	-5.3%	-6.4%	-6.0%	-5.3%	-5.9%	-7.3%	-7.1%
Assess	-3.9%	-9.4%	-11.0%	-12.0%	-10.0%	-10.0%	-11.0%	-8.9%	-9.4%
Personal Best	*	-10.0%	-10.0%	-9.2%	-9.1%	-7.2%	-6.5%	-6.6%	-2.9%
Mini-Wright	-4.8	-3.4%	-3.5%	-3.6%	-3.4%	-3.3%	-3.1%	-2.8%	-3.9%

* Impossible to measure due to measuring range on meter too low

<5.0%
Passes ATS & ERS limits

>5.0%, <10.0%
Fails ERS, passes ATS limits

>10.0%
Fails ERS & ATS limits

Tsukioka K. Department of Internal Medicine, National Nishi-Niigata Central Hospital, Niigata, Japan. November 1995 (ISBN4-87721-131-4)

Whilst many meters claim to meet the minimum requirements for accuracy and repeatability set by the NAEPP, it is clear that scientists and physicians recognize that not all meters provide the same peak flow reading. Not only does individual design and manufacturing processes affect the eventual PEF reading, but also the type of “scale” used – the original “Wright-McKerrow” scale used in Europe is now obsolete, but many meters remain in circulation, providing readings different to those obtained from ATS or EN13826 standards.

Analysis of the available literature on meter comparisons shows researchers frequently fail to define the type of scale of the meters being tested, which produces erroneous results (the various different scales can be viewed at the www.peakflow.com website).

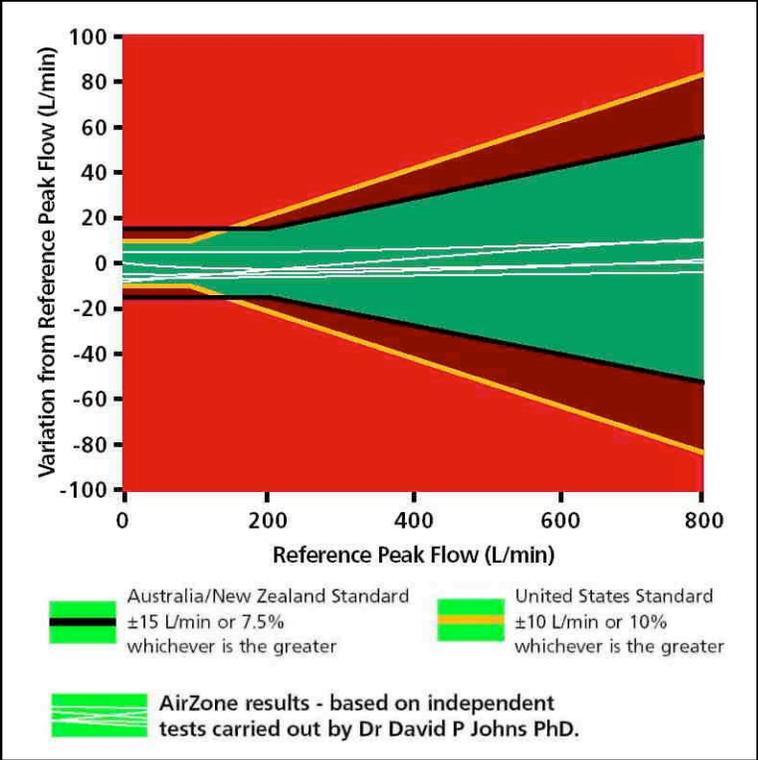


It is reassuring for those using Mini-Wrights to know that no matter what scale meter they have been using, the meter itself provides an accurate measurement of flow, and the design has been found to pass even the most demanding of laboratory tests. The growing number of copies of the original design is a tribute to its quality, and even the personal peak flow meter (AirZone) has been developed following extensive use of the Mini-Wright.

AirZone testing against Accuracy Standards for United States, and Australian and New Zealand Authorities

“I have evaluated a great number of different types of meter, both mechanical and electronic, over the years but yours [the AirZone] is one of the very few to so easily conform to the accuracy and reproducibility specifications and to be so well engineered.”

Dr. David P Johns PhD
Head Scientist, Dept. of Respiratory Medicine,
Alfred Hospital, Melbourne, Australia



What are the Normal PEF Values for Adults and Children

Various normal PEF values for adults and children are available, and although values differ across racial and ethnic populations, the well-respected values by Nunn and Gregg (Br Med J 1989;289:1068-72) have recently been adapted for the new European scale (EN13826). These new values are now directly suited to the ATS Scale PEF meter, as recommended by the NAEPP. The “Normal Values” can be downloaded from www.peakflow.com.

Where can I obtain more information ?

Additional resources can be obtained from your local Mini-Wright and AirZone distributor, or from the following websites: www.alliancetekmedical.com , www.peakflow.com or www.clement-clarke.com

- QA Documents on Mini-Wright and AirZone
- Recommended cleaning instructions
- Information on one-way mouthpieces
- Patient PEF charts and Normal Values

Distributed in your local area by:

