Peak expiratory flow rate (pefr) in lung diseases

PEFR value means peak expiratory flow rate that is a persons maximum speed of expiration. It can be measured by peak flow meter which is a simple device. People can use it monitoring their lung function in respiratory diseases. As a lung function test, it can be differentiated obstructive airway diseases such as asthma, COPD(chronic obstructive pulmonary diseases) from restrictive lung diseases. PEFR is mostly used to diagnosis asthma.

Normal PEFR value depends on several factors like age, sex, height, weight, etc. So the PEFR value varies with normal individuals and a Nomo gram is utilized as a scale. In obstructive airways diseases, normal value of PEFR is reduced corresponding to above factors.

As above factors, though PEFR value has some advantages, to diagnose obstructive airway diseases it can’t differentiate asthma from COPD.

Lung function tests, What is PEFR and how can we measure it, Importance in PEFR value in lung diseases have been included in this analytical essay.

Lung Function Test

Measurements of respiratory function may provide valuable information. First, in conjunction with the clinical assessment and other investigations they may help establish a diagnosis (1). Second, they will help indicate the severity of the condition. Third, serial measurements over time will show changes indicating disease progression or, alternatively, a favorable response to treatment. Finally, regular monitoring of lung function in chronic diseases such as idiopathic pulmonary fibrosis, cystic fibrosis or obstructive airways disease may warn of deterioration (1). Simple respiratory function tests fall into three main groups:

1. Measuring the size of the lungs
2. Measuring how easily air flows into and out of the airways
3. Measuring how efficient the lungs are in the process of gas exchange (1).

Pulmonary function can be measured by having a subject breathe into a device called a spirometer which recapture the expired breath and records such variables as the rate and depth of breathing, speed of expiration, and rate of oxygen consumption (2). The spirometer measures the FEV1 and the forced vital capacity (FVC). Both the FEV1 and FVC are related to height, age and sex. The technique involves a maximum inspiration followed by a forced expiration (for as long as possible) into the spirometer (3). The act of expiration triggers the moving record chart, which measures volume against time. Patients with severe airflow limitation may have a very prolonged forced expiratory time (3). At home asthma patient and others can monitor their respiratory function by blowing into a handled meter, measures peak expiratory flow rate (PEFR), the maximum speed at which they can exhale (2).

Peak Expiratory Flow Rate [PEFR]

Peak expiratory flow rate is the maximal rate of air flow which is a subject can achieve by a forced expiration. The peak flow, which is sustained for only a fraction of a second, occurs in the earliest part of expiration(4). The simplicity of the method is its main advantage. Normal person it is 400 Liter per minute(5). PEFR is measured by the subject inhaling to total lung capacity and exhaling into a peak flow meter with maximal effort PEFR measured using peak flow meter(6).

PEFR depends on some factors the sex, age, weight, height, body-size, and muscular forces of the individual subject(4). The normal value for a given person can be determined referring to a Nomo gram. In general, the taller or younger the individual, the higher is his PEFR Normal males have a higher PEFR than normal females of the same age and height. In normal males the range of PEFR lies between 450 and 700 liters per minute (L/min.). Normal females have a lower range between 300 and 500 L/min(4). It is lower in children than in adults. It is highest in early adult life, and decreases in old age. It is higher in tall people than in short people(7). PEFR may be unrecordable on the standard Wright peak flow meter which cannot measure PEFR if it is less than 60 L/min(4). Recently a low-range, peak flow meter has been introduced which will measure much lower values of PEFR This would be appropriate for use in children(4).

Peak flow meter

There are two different types of peak flow meters which are Wright’s peak flow meter and mini peak flow meter(4): which is an inexpensive, light and portable instrument(1, 4): that can be handled easily and use to get bedside measurement. This device used to monitor a person’s ability to breathe out air. This device is simpler and cheaper than spirometer. The first peak flow meter was designed by Wright and was fully described by Wright and McKerrow (1959). Recently another type of peak flow meter was presented. This device, named the Hildebrandt pneumometer, operates on an completely different principle from the Wright meter(4).

A report on the Hildebrandt pneumometer and its use in general practice is published elsewhere. In the present study all PEFR measurements were

made with a Wright meter. This operates on mechanical principles(4). The subject expires forcibly into the meter which causes a vane inside it to move against a spring resistance. The vane comes to rest at a position which depends upon the PEFR(4). attained. A pointer attached to the vane indicates PEFR on a dial which is calibrated in liters per minute. No calculations have to be made(4).

Method of taking PEFR measurements

This is an extremely simple and cheap test(3). Peak flow meter should be held horizontally and the dial must be in a vertical plane(4). Standing is the best position for taking measurements(7). It is measured using a standard Wright Peak Flow Meter or mini Wright Meter. The needle must always be reset to zero before PEF is measured. Care must be taken that the lips must be placed tightly around the mouthpiece and it is also important that he holds the meter correctly(4). The highest of three readings is used as the recorded value of the Peak expiratory flow rate(3). It may be tracks on graph paper chart with a record of symptoms or using peak flow mapping software. This allows patients to self-monitor and This allows patients to self-monitor and pass information back to their doctor or nurse. It is highly important that the subject not only understands what he is required to do but makes a maximal effort(4). If a subject has not previously performed the test careful explanation and instruction must be given followed by a demonstration blow by the doctor(4). Once the subject has gained confidence after one or two trial blows, Subjects are asked to take a full inspiration to total lung capacity and then blow out forcefully into the peak flow meter(4). Failure to observe that all these conditions are satisfied will result in serious errors. Different

brands and models of peak flow meters often yield different values when used by the same person. Hence patients should always use the same model in the home or the doctor’s clinic(7). At hospital, PEFR is measured using a low-reading peak flow meter, as an ordinary meter measures only from 60 L/min upwards(3).

Lung Diseases & PEFR

Respiratory disease

Lung diseases are something. Disease or disorder that occurs in the lungs or what is causing the light that does not work correctly (8). Lung diseases are the three main types, namely:

1. Obstructive airway disease: these diseases affect the Airways that carry oxygen and other gases to and from the lungs. These diseases cause the usually declining or blocking the airway. Including asthma, emphysema and chronic bronchitis (8). People who have respiratory diseases sometimes describe the feeling that “ you try to blow air through a chaff.”
2. Restrictive lung diseases: they are also called the lung tissue diseases. These diseases affect the configuration of lung tissue (8). Scarring or tissue inflammation makes the lungs cannot expand fully. This makes it difficult for the lungs breathe in oxygen and carbon dioxide out. Pulmonary fibrosis and sarcoidosis are examples of the lung tissue. People sometimes describe the feeling “ is very tight sweater or bestow” it will not be able to take a deep breath (8).
3. Lung circulation diseases: these diseases affect blood vessels in the lungs. Tread depth caused by coagulation or inflammation of the blood

vessels (8). They affect the lungs of oxygen and carbon dioxide out. These diseases may also affect heart function. Many lung diseases involve a combatiinon of these three types.

Asthma, Atelectasis, Bronchitis, COPD(chronic obstructive pulmonary disease), Emphysema, Lung cancer, Pneumonia, Pulmonary edema (2, 4, 8).

Importance of PEFR in Lung diseases

Determination of Peak expiratory flow rate is useful for assessing the respiratory diseases especially to differentiate the obstructive and restrictive respiratory diseases (5). Peak expiratory flow rate (PEFR) measurements on waking, prior to taking a bronchodilator and before bed after a bronchodilator, are particularly useful in demonstrating the variable airflow limitation that characterizes the disease (3). The diurnal variation in PEFR is a good measure of asthma activity and is of help in the longer-term assessment of the patient’s disease and its response to treatment. To assess possible occupational asthma, peak flows need to be measured for at least 2 weeks at work and 2 weeks off work (3). Generally PEFR in reduced in all type of respiratory diseases. However the reduction is more significant in the obstructive diseases such as asthma, emphysema, COPD (chronic obstructive pulmonary diseases) and chronic bronchitis than in the restrictive diseases (5). Sometimes in severe restrictive lung disease, PEFR values reduced much more. So in that conditions peak flow meter cannot be used to differentiate between restrictive lung diseases from obstructive airway diseases. So PEFR measurement is useful in management obstructive airway diseases. PEFR value is more important in asthma than other respiratory diseases.

Importance of PEFR in Asthma

Asthma is characterized by spastic contraction of the smooth muscle in the bronchioles, which partially obstructs the bronchioles and causes extremely difficult breathing (9). It occurs in 3 to 5 per cent of all people at some time in life. The usual cause of asthma is contractile hypersensitivity of the bronchioles in response to foreign substances in the air. In about 70 per cent of patients younger than age 30 years, the asthma is caused by allergic hypersensitivity, especially sensitivity to plant pollens (9). In older people, the cause is almost always hypersensitivity to nonallergenic types of irritants in the air, such as irritants in smog (9). Classically asthma has three characteristics:

- Airflow limitation which is usually reversible spontaneously or with treatment (3)
- Airway hyperresponsiveness to a wide range of stimuli (3)
- Inflammation of the bronchi with T lymphocytes, mast cells, eosinophils with associated plasma exudation, oedema, smooth muscle hypertrophy, matrix deposition, mucus plugging and epithelial damage (3). In chronic asthma, inflammation may be accompanied by irreversible airflow limitation as a result of airway wall remodeling that may involve large and small airways and mucus impaction (3).

Asthma is usually diagnosed by the demonstration of airflow limitation. PEFR variability as one of the important diagnostic features of asthma (10). Serial measurements of PEFR in most patients with asthma show spontaneous variability. The most characteristic pattern is of a circadian variation, with airflow limitation most severe on waking in the morning (and during the

night if awoken) with improvement occurring during the morning after waking. A small circadian variation in PEFR or FEV 1 is seen in normal individuals; in asthma a difference of 20 per cent or more between the highest and lowest values may be found (11). Other patterns of variation in severity of airflow limitation may be imposed on this circadian rhythm, such as falls in PEFR provoked by exercise or exposure to an allergen or occupational sensitizer, which resolve after avoidance of the stimulus. While variations of 20 per cent or more in FEV 1 or PEFR are commonly regarded as indicating asthma, in patients with severe airflow limitation, with an FEV 1 of 1 liter, 20 per cent variability equates to 200 ml, a level of spontaneous variation observed in people without asthma (11). In asthma, the resistance to airflow becomes especially great during expiration, sometimes causing tremendous difficulty in breathing (2).

Peak flow readings are divided in three zones of measurement, are green, yellow and red. Doctors and health experts can develop asthma controlling plan based on the green-yellow-red areas(12).

Green Zone —- 80 to 100 percent of the regular reading or normal peak flow is clearly a treatment in green zone peak flow indicates that is under good control(12).

Yellow Zone ——– 50 to 79 percent of the usual or normal peak flow readings Indicates caution. This can lead to respiratory system is restrictive. additional drugs may be required(12).

Red Zone —- 50% of the normal or usual peak flow readings indicate a medical emergency. serious airway narrowing may occurring and immediate

action needs to be taken. This would usually involve contacting a doctor or hospital (12).

The management of asthma relies on a patient’s ability to monitor their asthma regularly. PEFR Monitors changing in airflow limitation in asthma. People with asthma can use it to monitor themselves and alter their medication, as suggested by their doctor, at the first signs of any fall in peak flow measurement which indicates a descent in their condition. If the patient knows his best measurement of PEFR, drop in its value of up to 10 percent, indicates caution but no danger, as this much variation is not unexpected over a period of 24hours (7). A drop of 10 to 50 percent indicates that the patient is in danger of getting an attack. If the drop is more than 50 percent, the patients in an imminent danger of getting the attack. He must approach his physician who may examine him in the emergency department of the hospital (7). The correct knowledge of the PEFR predicts the condition of the patient and provides valuable time and opportunity to take all the necessary measures to prevent an attack of asthma (7).

Self-monitoring includes assessing the frequency and severity of symptoms (such as wheezing and shortness of breath) and measurement of lung function with a peak flow meter. (4) When measuring PEFR in patients with asthma or bronchitis, it is important to instruct them first to clear their bronchial airways by coughing. The effect of so doing may be considerable (4). Patients should be instructed to record peak flow readings after rising in the morning and before retiring in the evening. A diurnal variation in PEF (the lowest values typically being recorded in the morning) of more than 20% is considered diagnostic and the magnitude of variability provides some

indication of disease severity (13). People with asthma can use it to monitor themselves and alter their medication, as suggested by their doctor, at the first signs of any fall in peak flow measurement which indicates decline in their condition. There are some significance PEFR in asthma patient the decreased rates of expiration of air as expressed in decreased PEFR in asthma patients, occur earlier than the production of the symptom of breathlessness or even the signs of wheeze and ronchi detected through the stethoscope. By the time, wheezing is detected through the stethoscope; the PEFR has already decreased by 20 percent or more (7). Poor perception of the severity of asthma, on the part of the patient and physician, has been cited as a major factor causing delay in treatment, and this may contribute to increased severity and mortality from asthma exacerbation (7). Patients also measured PEFR twice a day (morning and evening) by using a peak flow meter before self-administering asthma drugs and noted the PEFR value in their asthma diary.

Acute severe asthma the term ‘ status asthmaticus’ was defined as asthma that had failed to resolve with therapy in 24 hours. In this condition, PEFR is < 50% of predicted normal or best. In features of life-threatening attacks, PEFR is < 30% of predicted normal or best (approximately 150 L/min in adults). (4)If the PEFR is less than 150 L/min (in adults), an ambulance should be called. (All doctors should carry peak flow meters).

Circadian rhythm in peak expiratory flow rate in a patient with asthma recovering from an acute attack (11)

Brittle asthma(11) is characterized by widely varying peak flow rates uncontrolled by maximum inhaled treatment. Two patterns of brittle asthma have been distinguished:

1. type I-persistent daily chaotic variability in peak flow (usually greater than 40 per cent diurnal variation in PEFR more than 50 per cent of the time); (11)
2. type II-sporadic sudden falls in PEFR against a background of usually well-controlled asthma with normal or near normal lung function.(11)

A drop of PEFR also indicates that the patient has been exposed to allergenic environments. He must try to localize the cause and prevent recurrence of the situation. PEFR reading also helps in monitoring the improvement in the patient after a particular mode of treatment (7).

The following patients should keep a peak flow monitor at home and use it: (7)

1. Patients who experience severe attacks with little warning.
2. Patients who need to travel long distance to receive medical attention.
3. Patients who require high-dose inhaled corticosteroids or daily oral corticosteroids.
4. Patients with big ups and downs in peak flow, that is, greater than 20 percent of their best peak flow.
5. Patients whose medical history appears to provide an unsatisfactory guide to treatment.

There are two very important reasons for taking flow reading at home. First, asthma doesn’t behave the same way 24 hours a day. It tends to get

spontaneously worse at night and get better during the day (7). Without peak flow meter at home, the physician can only guess how the patient was doing at home. Second, having a meter at home allows the patient to telephone the doctor during the night and get proper instructions for management of his case. Nine times out of ten, a Physician experienced with home peak flow, can help get his patient out of trouble quickly and avoid uncalled for visit to an emergency room or hospital (7).

PEFR use in Chronic obstructive Pulmonary Diseases (COPD)

Chronic obstructive pulmonary disease (COPD) refers to any disorder in which there is a long-term obstruction of airflow and a substantial reduction in pulmonary ventilation (2). The major COPDs are chronic bronchitis and emphysema. This is obstructive airway diseases like Asthma. They are almost always caused by cigarette smoking, but occasionally result from air pollution or occupational exposure to airborne irritants (2). Like in asthma, variability of PEFR value is important in diagnosing and after prognosing of COPD.

Patients with chronic bronchitis are unlikely to achieve a P. E. F. higher than 400 L/min: if their condition is complicated by emphysema, values of less than 200 L/min are usually found (4). In severe emphysema or in status asthmaticus PEFR may be unrecordable on the standard Wright peak flow meter which cannot measure PEFR if it is less than 60 L/min (4).

The importance of identifying chronic bronchitis at a stage before serious, irreversible changes have occurred should need no stressing. Unfortunately, the early symptoms of chronic bronchitis are so unobtrusive that patients

seldom attach any importance to them: (4) therefore early chronic bronchitis is likely to be recognized only if it is specially looked for. Nobody is better placed to do this than the general practitioner now that his task has been made less formidable by the provision of objective means of assessment. Though the limitations of PEFR as an index of early chronic bronchitis have yet to be fully measured, there is no doubt that a peak flow meter will enable general practitioners to identify many early bronchitis with much greater confidence than is possible on clinical findings alone (4).

Other uses

Also absolute peak expiratory flow rate (PEFR) has been a valuable measurement in the differentiation of acute dyspea secondary to congestive heart failure (CHF) or chronic lung disease (CLD) (15)

In experimental research, it was discovered the mean absolute PEFR was 229. 9 L / min for the congestive heart failure group and 121. 12 L / min for the CLD group; the difference was significant. No single cut off value allowed 100 % accurate classification. However, a PEFR greater than 150 L / min was suggestive of CHF. Whereas a reading less than or equal to 150 L / min was suggestive of CLD. The Peak Expiratory Flow Rate (PEFR) is Valuable in differentiation between CHF and CLD (15).

Advantages and Disadvantages of PEFR

There are some advantages and disadvantages utilizing peak flow meter in management of respiratory diseases.

A peak flow meter that is an inexpensive, portable, handheld device and need no source of electricity and require the minimum of maintenance (4),

can be used at the bedside, can be bought any person from market. Peak flow meters are very helpful if person have moderate to severe asthma and require daily asthma medications. Even children ages 4 to 5 and up should be able to use a peak flow meter with good results. People with moderate-to-severe asthma should have a peak flow meter at home (14).

Although reproducible, PEFR is not a good measure of airflow limitation since it measures the expiratory flow rate only in the first 2 ms of expiration and overestimates lung function in patients with moderate airflow limitation (3). PEFR is best used to monitor progression of disease and its treatment. Regular measurements of peak flow rates on waking, during the afternoon, and before bed demonstrate the wide diurnal variations in airflow limitation that characterize asthma and allow an objective assessment of treatment to be made

It can be difficult to distinguish between asthma and COPD(3): that are same feature respiratory diseases. Also a significant peak flow variability is present in, bronchiectasis, and PTLD, although PEFR remains the most important feature favoring the diagnosis of asthma (10). So there are some difficulties in differentiation of asthma from other obstructive respiratory diseases each other. This is Effort-dependent Poor measure of chronic airflow limitation (3). Older people with poor vision have difficulty reading PEF meter recordings (6).

It is important to know that peak flow meter only measures the amount of airflow out of the large airways of the lungs (14). Changes in airflow caused by the small airways (which also occur with asthma) will not be detected by

a peak flow meter. Early warning signs, however, may be present. Therefore, it is important, symptoms and early warning signs to best manage in asthma.

The most clinically useful measurements of airflow limitation except PEFR are forced expiratory volume in 1 s (FEV 1), which may be expressed as a proportion of the forced vital capacity (FVC) as FEV1/FVC per cent (11). Both tests require the patient to provide a reproducible maximal forced expiratory maneuvers using tested and validated equipment. FEV1 has the advantage of a visible tracing of the expelled volume of air over time, which allows the observer to determine whether reproducible maximal forced expiratory manoeuvres have been made (11). PEFR testing does not provide this opportunity. However, peak flow meters employed to measure PEFR, unlike spirometers required to measure FEV1, can be used regularly by patients to monitor their lung function (11).