Commentary

Clinical application of spirometry in asthma: Why, when and how often?

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INTRODUCTION

Spirometry is an extremely useful investigation in pulmonary medicine. In chronic diseases such as asthma, it is grossly under-utilized, not only in India but in other countries as well. Besides lack of facilities for good spirometry in most cities and towns, and inadequate attention to quality control even where it is available, there is often a poor comprehension and uncertainty on why, when and how often it should be advised as well as on its clinical applications. This commentary examines several issues related to the use of spirometry in asthma.

Diagnosis of asthma

Airways obstruction and its reversibility

While a clinical evaluation of the cluster of symptoms and the pattern of their occurrence is usually sufficient to provide a diagnosis of asthma and start treatment, demonstration of airways obstruction and its reversibility (a greater than 12% and 200 ml increase in FEV_1) following inhalation of a bronchodilator is recommended to confirm the clinical diagnosis.[1] A normal spirometry in the presence of symptoms raises the possibility of an alternative diagnosis. In patients with an apparently difficult asthma, the finding of a normal spirometry also suggests a wrong diagnosis.

In a quality-assured spirometry, a reduced ratio of FEV1 to FVC indicates airflow limitation.[2] It is not often realized that the GOLD definition of airways obstruction (a post-bronchodilator ratio of less than 70%) is strictly applicable only to Chronic Obstructive Pulmonary Disease (COPD) and not to other airway diseases. The diagnosis of airways obstruction, in general, is made using the *pre-bronchodilator* ratio of FEV1 to FVC showing a value less than the lower limit of normal (LLN).[2] The LLN is defined as the predicted value minus (1.645 x standard error of estimate). The predicted value and the standard error of estimate are derived from the reference equations for the population. In children, the ratio may normally be as high as 90%.

Yet, spirometry has limitations. In patients who are well-controlled on treatment or in complete remission, it may be normal. Patients with near-normal spirometry or severe asthma may not show reversibility of airways obstruction due to airway remodelling. A proportion of patients with COPD may have significant reversibility.[3] Thus, acute response to bronchodilator has limited value in differentiating asthma from COPD and spirometry should not be used in isolation to establish a diagnosis of asthma, rather, used only to support and confirm a clinical suspicion.[4]

Variability of airways obstruction

Variability of airway caliber, either spontaneously or with treatment, is the characteristic and defining feature of asthma and may be demonstrated either by a large improvement or deterioration in spirometry. This requires serial spirometry over a few days or weeks and is also confirmatory of a diagnosis of asthma.[1] An increase or decrease in FEV1 of >12% and >200 mL from baseline documents variability and may be useful in patients in whom an acute bronchodilator response is not observed.

Airway hyperresponsiveness

In patients with a normal spirometry, variability may also be demonstrated by bronchial provocation testing to assess airway hyper-responsiveness. Most often a challenge with inhaled methacholine is used but an exercise challenge also provides the same information. The response is measured by spirometry. If the estimated dose of methacholine producing a 20% decrease in FEV1 (called Provocation concentration, PC20) is less than 8 mg/ml, the bronchial challenge test is considered positive.[5] However, because of only a moderate specificity, a positive test is not necessarily diagnostic of asthma. An exercise challenge producing a 10% decrease in FEV1 a few minutes after stopping exercise indicates exercise-induced bronchospasm.[6] However, the test has a limited sensitivity and therefore is not reliable as a diagnostic test for asthma but only confirms the role of exercise as a triggering factor.

Assessment of control of asthma

The GINA 2014 has defined two domains to assess and monitor the response to treatment: Assessment of control and determination of risk of future adverse outcomes.[1]

Assessment of control

An assessment of control is required on every follow-up visit to take a decision on any change in treatment. The proposed method in the current GINA guidelines is based

on assessment of daytime and night-time symptoms, use of rescue bronchodilator and activity limitation. Spirometry is not required to step-up the treatment.[1] However, use of validated control instruments, such as the Asthma Control Questionnaire (ACQ) has an item on the FEV1 value.[7] On the other hand, the other frequently used instrument, the Asthma Control Test (ACT) does not require spirometry.[8]

Assessment of risk of adverse future outcomes

Lung function is an informative indicator of the future risk of adverse outcomes. A low FEV1, <60% predicted is a potentially modifiable independent risk factor for exacerbations besides being a risk factor for developing fixed airflow limitation.[9-11] Serial testing may identify patients with a faster decline in lung function.

Attainment of goals of management

One of the goals of management of asthma is to attain normal or near-normal lung function.[1] While this is a realistic goal in most patients, a significant proportion of patients, especially those with a moderate or severe disease may never attain a normal lung function. These patients are generally more difficult to manage having developed an "irreversible" component due to airway remodelling. During the course of management, spirometry carried out on optimum treatment and when the patient is well-controlled would show whether the lung function has been normalized.

Other issues in spirometry in asthma

Frequency of testing

Considering the multiple applications of spirometry in asthma discussed above, it is not possible to make a recommendation of the frequency of testing. How often to carry out spirometry during the course of a follow-up is an individualized decision and also depends on what information is sought from the test. The GINA 2014 report makes a very broad suggestion that lung function should be measured at diagnosis and start of treatment, 3-6 months after starting controller treatment, and then periodically.[1]

Should bronchodilator responsiveness be assessed on every visit?

Demonstration of reversibility of airways is part of the diagnostic work-up and therefore should normally be required only initially. Sometimes, acute reversibility may not be evident at the first evaluation but may be observed on a subsequent visit. Once the diagnosis is confirmed, further testing may be restricted to pre-bronchodilator spirometry as management decisions are not based on bronchodilator responsiveness but on assessment of control.

Is drug withdrawal necessary at each test?

At the time of establishing the diagnosis, spirometry should be carried out before and after administration of 400 μg salbutamol using a metered dose inhaler. This requires an overnight withdrawal of short-acting bronchodilators and 24 hours for longer acting.[12] Once the diagnosis of asthma has been confirmed, drug withdrawal is generally not necessary as patients now need to be assessed for their functional status while on medication. However, comparisons of serial tests should only consider pre-bronchodilator values.

The concept of personal best test

When spirometry is carried out for the first time, the data is compared with predicted values. However, predicted values are not necessarily the goal or the target of treatment. There is a wide range of normal values around the predicted values which only represent the 50th percentile. A patient's "normal" value may be anywhere between the LLN and predicted values or even above it. There is no upper limit of normal in spirometry. Thus, a patient's "personal best" value needs to be established and is usually the one obtained during a period of complete control with optimum treatment. This then serves as the goal for subsequent assessments. It needs to be emphasized that a patient's personal best may be below the LLN if airway remodelling has occurred leading to persistent obstruction.

How should the change in forced vital capacity be interpreted?

A 12% and 200-ml increase in FEV1 or FVC indicates bronchodilator responsiveness.[2,12] However, both GINA[1] and British 2014 Asthma guidelines[13] are silent on the use of FVC as a parameter of evaluation. We have previously shown that majority of patients of asthma respond acutely to a bronchodilator with either an increase in both FEV1 and FVC or only FEV1 when FVC is in the normal range.[3] However, some asthmatics, especially those with severe airways obstruction and air trapping may respond with an isolated FVC response that may be overlooked if only FEV1 is considered.[3]

Defining severity of asthma

The previous classification of severity by the GINA guidelines into mild intermittent and persistent (mild/moderate/severe) was based on symptoms, activity limitation and the FEV1 value.[14] However, the 2014 GINA guidelines have excluded spirometry for classifying the severity of asthma. Severity is now assessed retrospectively from the level of treatment required to control symptoms and exacerbations and categorized into mild, moderate and severe.[1]

Can spirometry results be used to change treatment?

The GINA-recommended stepping-up of treatment is based on assessment of control and not on spirometry.[1] Whereas stepping-up treatment in a symptomatic patient is logical, an upward revision of treatment in poor perceivers requires spirometry. Spirometry is useful in identifying patients who perceive symptoms poorly and thus in whom a symptom-based assessment of control is likely to overestimate the level of control and result in under-treatment.

The GINA 2014 guidelines recommend stepping down of treatment once good control has been maintained for 3 months. However, stepping down treatment without normalizing the lung function or achieving the 'personal best" may lead to a relapse of symptoms as their absence does not rule out the presence of airways obstruction and active disease. Hence, the GINA 2014 guidelines also emphasize that lung function should have reached a plateau before considering stepping-down.[1]

There is a caveat on the application of spirometry. The information obtained on spirometry may be misleading if meticulous quality control is not exercised in equipment selection and maintenance, calibration, operator training and competence, and patient performance.[12] It is also imperative that prediction equations developed in local population be used for interpretation of data and avoid misclassification that are inevitable if inappropriate equations are used. The equations for Indian population, using current standardization of spirometry, have been published recently.[15]

REFERENCES

1. Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention. 2014. Available from: http://www.ginaasthma.com. [Last accessed on 2014 Feb 22].
2. Lung function testing: Selection of reference values and interpretative strategies. American Thoracic Society. Am Rev Respir Dis 1991;144:1202-18.
3. Chhabra SK, Bhatnagar S. Comparison of bronchodilator responsiveness in asthma and chronic obstructive pulmonary disease. Indian J Chest Dis Allied Sci 2002;44:91-7.
4. Chhabra SK. Acute bronchodilator response has limited value in differentiating bronchial asthma from COPD. J Asthma 2005;42:367-72.
5. Chhabra SK. Bronchial hyperreactivity: Measurement and its applications. Indian J Chest Dis Allied Sci 1986;28:222-30.
6. Parsons JP, Hallstrand TS, Mastronarde JG, Kaminsky DA, Rundell KW, Hull JH, *et al*.; American Thoracic Society Subcommittee on Exercise-induced Bronchoconstriction. An official American Thoracic Society clinical practice guideline: Exercise-induced bronchoconstriction. Am J Respir Crit Care Med 2013;187:1016-27.
7. Juniper EF, O'Byrne PM, Guyatt GH, Ferrie PJ, King DR. Development and validation of a questionnaire to measure asthma control. Eur Respir J 1999;14:902-7.
8. Nathan RA, Sorkness CA, Kosinski M, Schatz M, Li JT, Marcus P, *et al*. Development of the asthma control test: A survey for assessing asthma control. J Allergy Clin Immunol 2004;113:59-65.
9. Fuhlbrigge AL, Kitch BT, Paltiel AD, Kuntz KM, Neumann PJ, Dockery DW, *et al*. FEV (1) is associated with risk of asthma attacks in a pediatric population. J Allergy Clin Immunol 2001;107:61-7.
10. Osborne ML, Pedula KL, O'Hollaren M, Ettinger KM, Stibolt T, Buist AS, *et al*. Assessing future need for acute care in adult asthmatics: The Profile of Asthma Risk Study: A prospective health maintenance organization-based study. Chest 2007;132:1151-61.
11. Ulrik CS. Outcome of asthma: Longitudinal changes in lung function. Eur Respir J 1999;13:904-18.
12. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates RA, *et al*.; ATS/ERS Task Force. Standardisation of spirometry. Eur Respir J 2005;26:319-38.
13. British Thoracic Society; Scottish Intercollegiate Guidelines Network. British guideline on the management of asthma. Thorax 2014;69(Suppl 1):1-192.
14. Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention. 2013. Available from: http://www.ginasthma.com. [Last accessed on 2014 Feb 22].
15. Chhabra SK, Kumar R, Gupta U, Rahman M, Dash DJ. Prediction equations for spirometry in adults from northern India. Indian J Chest Dis Allied Sci 2014;56:221-30.

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