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UNIT NO. 3

SPIROMETRY IN ASTHMA

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ABSTRACT

Asthma is a common respiratory condition seen in primary care. It is characterised by common respiratory symptoms and variable expiratory airflow limitation due to underlying chronic airway inflammation. Diagnosis should be established promptly to prevent misdiagnosis and inappropriate management. Objective lung function assessment is therefore recommended to guide the primary care physician. This article describes the use of spirometry, its role in the diagnosis of asthma and assessment of asthma control. Barriers to the use of spirometry in primary care are also discussed with suggested interventions.

Keywords:
Asthma; respiratory system; pulmonary ventilation; spirometry; primary care

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INTRODUCTION

The worldwide prevalence and burden of asthma are increasing with a similar trend in Singapore. In 2017, asthma is estimated to affect 4.1 percent of Singaporeans aged 15 and above.[1] Asthma is a heterogeneous condition, usually characterised by chronic airway inflammation. It presents with common respiratory symptoms such as breathlessness, wheezing, chest tightness and cough that vary over time and in intensity with variable expiratory airflow limitation.[2] A history of characteristic respiratory symptoms alone is often insufficient to confirm the diagnosis of asthma. Spirometry is a useful tool for physicians in the diagnosis of asthma and assessment of asthma control. However, it is still very much underutilised, especially in primary care settings. This article gives a summary on the spirometry test, interpretation in the context of asthma, its role in the assessment of asthma diagnosis and control, and the barriers to the use of spirometry in primary care.

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SPIROMETRY

As spirometry can provide an objective measurement of lung function, indications include diagnosing pulmonary disease, quantifying the extent of known disease on lung function, measuring the effects of occupational or environment exposure, determining the effects of therapy and assessing pre-operative risks (Table 1).[3]

Guidelines on contraindications to spirometry have largely been based on expert opinion, with no randomized controlled trials published on them. A reasonable guiding principle is that the beneficial information obtained from a spirometry outweighs the risks of performing it. Some commonly suggested contraindications are:[4]

- Myocardial infarction within last one month
- Unstable angina
- Pulmonary embolism within last one month
- Recent stroke
- Recent cerebral, eye, ear, thoracic or abdominal surgery
- Known aortic or cerebral aneurysm
- Uncontrolled hypertension (systolic > 180 mm Hg, diastolic > 120 mm Hg)
- Hypotension (systolic < 90 mm Hg)
- Pneumothorax
- Massive haemoptysis
- Haemodynamically unstable patient
- Infection concerns such as active pulmonary tuberculosis, influenza

Bronchodilators are generally withheld before a spirometry test, especially if evidence of bronchodilator reversibility is being sought.[3] However, it will not be necessary to withhold these medications if the purpose of the spirometry is to determine the response to existing treatment. Short acting beta-2 agonists and anti-cholinergics (salbutamol and ipratropium) should not be used within four hours of test. Long acting beta-2 agonists (salmeterol and formoterol) should be stopped for at least 12 hours. Other longer acting bronchodilators (tiotropium, vilanterol, olodaterol, indacaterol, umeclidinium, glycopyrronium, slow release theophylline) may need to be withheld for 24 to 48 hours prior to spirometry. Patients should be advised to avoid vigorous exercise within 30 minutes, smoking within an hour, large meals within two hours, and alcohol consumption within four hours of spirometry testing.[5]

There are currently many handheld portable spirometers in the market. However, a good quality spirometer is crucial for reliable results. Careful consideration should be given to the training of dedicated staff, the cost, quality, maintenance and technical support of spirometers. American Thoracic Society/European

Respiratory Society document on standardisation of spirometry provides some guidance on the expected technical specifications for spirometers.[3] Another alternative for primary care physicians is to consider getting direct access to spirometry testing in restructured or private hospitals.

HOW TO PERFORM A SPIROMETRY

1. Check the spirometer
2. Obtain the patient's age, height, weight, gender and ethnicity
3. Review indications and contraindications
4. Ensure correct position and posture (sit upright, feet on ground, slightly extended neck and upright chin)
5. Explain the steps of the test with demonstration
6. Use a nose clip
7. Ensure tight lip seal around mouthpiece
8. Inhale completely and rapidly
9. Exhale maximally until no more air can be expelled
10. Repeat for a minimum of three manoeuvres, but no more than eight
11. Administer four puffs of salbutamol (100 mcg per puff, at 30-second interval)
12. Rest for 15 minutes
13. Repeat spirometry to assess for post bronchodilator response

A manoeuvre is acceptable if it has a good start, is free from artefacts and has a satisfactory exhalation beyond six seconds or reaching plateau. After three acceptable manoeuvres have been performed, the two largest values of FEV1 and FVC must be within 0.150L of each other[3] for between manoeuvre acceptability.

SPIROMETRY IN THE DIAGNOSIS OF ASTHMA

Many other conditions can present in a similar way to asthma. Differential diagnoses include chronic obstructive pulmonary disease, bronchiectasis, other parenchymal lung diseases, cardiac failure, dysfunctional breathing and inducible laryngeal obstruction. It is therefore essential to confirm the diagnosis of asthma with thorough history taking and documentation of expiratory airflow obstruction and excessive variability in lung function. It is also recommended to demonstrate the presence of variable expiratory airflow obstruction as soon as possible, preferably before the initiation of anti-inflammatory treatment with inhaled corticosteroids. It will be harder to confirm the variability once anti-inflammatory therapy has been started.

The two important measurements obtained from a spirometry are forced expiratory volume in first second (FEV1) and forced vital capacity (FVC). FEV1 is the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration. FVC is the maximal volume of air exhaled with maximally forced effort from a maximal inspiration. An expiratory airflow obstruction is defined as a disproportionate reduction of FEV1 in relation to FVC, causing a low FEV1 to FVC ratio (FEV1/FVC ratio). Many international guidelines[6,7] use a fixed ratio of 0.7, which tends to result in overdiagnosis of obstructive airway disease in adults above 40 years. A fixed ratio also tends to underestimate airflow obstruction in children where a normal ratio can be higher than 0.9. American Thoracic Society/European Respiratory Society task force (ATS/ERS) in the standardisation of lung function testing[3] has recommended using the lower limit of normal (LLN) which is the fifth percentile of the reference population.

In adults with typical respiratory symptoms, excessive variability can be demonstrated as an increase in lung function after administration of bronchodilator or a four-week trial of controller treatment.[2] A positive bronchodilator response or good response to controller treatment is defined as at least an increase in FEV1 of 12 percent and 200 mL from baseline. There is greater confidence of an asthma diagnosis when there is an increase in FEV1 of more than 15 percent and 400 mL. Most children can perform spirometry from the age of six. In children, a positive bronchodilator response is defined as at least an increase in FEV1 of 12 percent from baseline. It must be emphasised that a normal spirometry or the absence of positive bronchodilator response does not necessarily exclude a diagnosis of asthma. Repeat spirometry testing or further bronchoprovocation testing may be required. An increase or decrease in FEV1 of 12 percent and 200 mL from baseline between visits may still indicate excessive variability in lung function. A referral to specialist may be warranted if respiratory symptoms persist despite a normal or non-diagnostic spirometry.

SPIROMETRY IN THE ASSESSMENT OF ASTHMA CONTROL

It is unclear how often a spirometry should be performed. A general recommendation from GINA 2019 main report is repeating spirometry after three to six months of controller treatment and periodically after that. A patient's personal best lung function should be recorded for purpose of subsequent assessments. A low FEV1 of less than 60 percent predicted is a strong independent risk factor of future asthma exacerbations regardless of symptoms experienced.[8,9] Patients with uncontrolled asthma may also have an accelerated lung function decline,[10] leading to persistent airflow limitation. This should prompt the physician to treat aggressively and follow up closely with repeat testing. While FEV1 value alone does not correlate strongly with asthma symptoms,[11] it still features as an item on the validated 7-question Asthma Control Questionnaire (ACQ) together with asthma symptoms. Asthma Control Test (ACT) is more commonly used in Singapore and does not take into consideration the FEV1 value. Patients with uncontrolled asthma despite adequate anti-inflammatory treatment may be candidates for bronchial thermoplasty if they have persistent bronchodilator reversibility.[12]

BARRIERS TO THE USE OF SPIROMETRY IN PRIMARY CARE

Despite the importance of spirometry in the diagnosis and management of obstructive airway diseases, spirometry is often underutilized in primary care.[13,14] A small unpublished survey of general practitioners in Singapore showed that 81 percent

would consider spirometry for assessing asthma diagnosis. However, only 25 percent of them eventually sent their patients for spirometry.

Key barriers to the use of spirometry in primary care can be divided into practitioner, resource and patient factors. Practitioner factors include a lack of conviction on the value of spirometry, lack of expertise in performing and obtaining good quality spirometry data and lack of confidence in interpreting spirometry.[13,15-19] Resource barriers include lack of access to a well maintained spirometer,[13,15] lack of trained staff, increased time required for spirometry,[13,19] difficulty integrating spirometry into patient flow,[15] and increased cost to providers.[16,19] From the patients' perspective, they face increased cost, and may also be reluctant to undergo spirometry[13] due to inconvenience. Patient factors are often a less cited reason.

Understanding these barriers, interventions that have been suggested to promote the use of spirometry in primary care include the need for more training in the value, performance and interpretation of spirometry. Further training may be web based, but will likely also involve hands on training on the set up and operation of the spirometer.[20,21] Additional educational outreach visits by pulmonary function technicians may have added value as well[21]. It is suggested that there are unnecessary parameters in the spirometry readout, which can potentially be simplified to improve ease of interpretation.[22] To increase the primary care physician's access to spirometry, more advice on the choice of spirometers and economics of spirometry can be provided.[13,22]

CONCLUSIONS

While the armamentarium for the treatment of asthma is rapidly expanding, we need to get our basics right from the start. We recognise the usefulness of spirometry in the diagnosis of asthma and assessment of asthma control. It is essential to exclude other respiratory conditions that mimic asthma. Objective lung function assessment can help us provide better asthma care for our patients. Spirometry remains underutilised in primary care. Challenges of providing spirometry test in primary care need to be overcome.

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LEARNING POINTS

- **Asthma presents with variable respiratory symptoms and expiratory airflow limitation.**
- **Spirometry is a useful but underutilised tool in the assessment of asthma diagnosis and control.**
- **Normal spirometry in an asymptomatic patient does not rule out the diagnosis of asthma.**

Table 1: Indications for Spirometry[3]

Diagnostic
• To evaluate symptoms, signs or abnormal laboratory tests • To measure the effect of disease on pulmonary function • To screen individuals at risk of having pulmonary disease • To assess pre-operative risk • To assess prognosis • To assess health status before beginning strenuous physical activity programmes
Monitoring
• To assess therapeutic intervention • To describe the course of diseases that affect lung function • To monitor people exposed to injurious agents • To monitor for adverse reactions to drugs with known pulmonary toxicity
Disability/Impairment Evaluations
• To assess patients as part of rehabilitation programme • To assess risks as part of an insurance evaluation • To assess individuals for legal reasons
Public Health
• Epidemiological surveys • Derivation of reference equations • Clinical research