Review article

DIAGNOSING AND MANAGING CHILDHOOD ASTHMA EFFECTIVELY WITH LIMITED RESOURCES

André van Niekerk[1]
Eugene G Weinberg[2]

[1] *UP Chair for Inborn Errors of Immunity & Allergology, School of Medicine, University of Pretoria and Steve Biko Academic Hospital, South Africa*
[2] *Allergy and Immunology Unit, UCT Lung Institute, South Africa*

Email | andre.vanniekerk@up.ac.za

SUMMARY

Childhood asthma must be diagnosed and managed correctly. It is the most common and potentially fatal chronic non-communicable disease in children. The prevalence of asthma is increasing in both resource-limited and well-resourced settings. Up to 96% of asthma deaths occur in low- and middle-income countries where medical care must often be offered against a background of limited resources. Simple diagnostic steps, accessible treatment options and a good understanding of childhood asthma and asthma education will benefit all asthmatic patients, especially those who rely on resource-limited healthcare. This review is not an academic appraisal of data on the topic; it aims instead to extract practical solutions from asthma guideline documents to bring correct diagnoses and simple, yet effective management options to resource-limited settings.

Keywords: childhood asthma, resource-limited setting, practical solutions

INTRODUCTION

Limited resources are a reality in many healthcare settings; asthma is a reality in all healthcare settings. Asthma remains the most common potentially fatal chronic non-communicable disease in children and must be diagnosed and managed correctly to improve quality of life (QoL), avoid morbidity and mortality and to avoid medication side-effects. The diagnosis and management of asthma is difficult. On the one hand, it is often underdiagnosed and incorrectly treated; on the other, it is often overdiagnosed and overtreated.[1] Resource limitations will have a further negative impact on asthma diagnosis and management. Even when we get it right, we often fail to achieve optimal long-term management. This is wrong.

The debate on asthma prevalence and the urban–rural gradient is ongoing. The overall prevalence may seem lower in rural areas,[2,3] but a lower prevalence should not promote complacency. The current prevalence of asthma in adolescents (as reported in a sample representing the Cape Town demographic population profile) was 21.3%. Of wider concern is the prevalence of an increasing severity of asthma found in the same population.[4] South Africa ranks amongst the highest in the world for asthma-related deaths.[5] The risk of ever wheezing and having more than three wheezing episodes in a year is higher in rural locations.[3] Up to 96% of asthma deaths occur in low- and middle-income countries[6] and South Africa is no exception regarding failed intervention.[7]

We may be tempted into equating rural areas with limited resources, but this is also not true. Factors such as supply chain interruptions, budgetary constraints, access to healthcare facilities, inadequate understanding (by patients and providers) and communication difficulty may reduce any service anywhere to one of limited resources. These problems are also not uncommon at urban facilities. However, affordable cost-effective medication and simple diagnostic and management plans are available. The healthcare worker who applies their mind to a better understanding of the diagnosis and effective management of childhood asthma will be an asset to any community, especially to one that is resource-limited.

GETTING THE DIAGNOSIS RIGHT WITH LIMITED RESOURCES

The diagnosis of asthma may be difficult in well-resourced and even more so in resource-limited settings. Different forms of pulmonary function testing and markers of inflammation are helpful in diagnosing and characterising asthma phenotypes, but these tests are often not accessible in resource-limited settings. However, the diagnosis of asthma is to a significant extent a clinical one: it is therefore imperative that healthcare workers know, understand and seek the defining criteria of an asthma diagnosis.

Asthma is a chronic inflammatory disease of the airways that manifests with episodes of chest tightness, wheeze, cough and

variable expiratory airflow limitation (EFL). The airflow limitation may become persistent in long-standing asthma.[6] But whereas the symptoms of asthma are not specific to asthma only, it is the variable EFL that defines asthma. Healthcare workers should guard against simply diagnosing asthma because of reported symptoms that can be associated with asthma. They should seek proof of variable EFL at every opportunity.

The South African Childhood Asthma Working Group[8] suggests a four-step approach to the diagnosis of asthma in children, suggestions that also apply to resource-limited settings. The answers to the four steps will help to 'build' a diagnosis of asthma and will always require a detailed history and proper clinical examination. Relatively simple special investigations will add to the building blocks of the four steps. A clinician who applies their mind to a better understanding of these steps will be empowered to diagnose asthma more accurately. These four steps are described in what follows: history-taking; confirm episodes of variable airflow limitation; ascertain nature of underlying inflammation; and consider conditions that mimic asthma.

STEP 1: HISTORY-TAKING

The first step towards an asthma diagnosis is to obtain a detailed history. The history is usually the most powerful diagnostic tool available for treating children.

Asthma is an inflammatory airway disease that usually results from pro-inflammatory immune dysfunction. It does not suddenly happen, such as with the aspiration of a foreign body. It evolves over time and then, unfortunately, often declares itself only during an acute exacerbation. The onset of asthma is associated with genetic and epigenetic predispositions. Certain risk factors favour the inception of asthma and these factors can be identified with a detailed history.

Children born to an asthmatic parent (especially the mother) are more likely to develop asthma. This risk is significantly increased when both parents are asthmatic. Babies born by caesarean section delivery (especially elective caesarean section delivery before the rupture of the amniotic membranes)[9,10] are more likely to develop asthma. This is also the case with children who failed breastfeeding, who received antibiotics more frequently in early life and whose mothers smoked.[6] These factors are associated with the early development of allergic disease. Allergic disease is associated with the inception, persistence and severity of asthma. It is especially atopic dermatitis (AD) (and more severe forms of AD) that warn about the risk for the onset of asthma.[11] Recurrent infection-associated wheeze is also associated with an increased risk for the inception of asthma. It is ultimately an early-life sensitisation to allergens and infection-associated wheezing illnesses (each alone or in combination) that are major risk factors for the onset of asthma.[12]

The age of onset of symptoms is important. Up to 80% of asthmatic children will present before their fifth birthday, but asthma evolves over time. Events from a very early age (especially during the first year of life) should raise a suspicion as to a possible alternative diagnosis. The child who presents with typical symptoms after two or three years of age is more likely to be asthmatic.

The characteristics of the suspected asthma events are also important. The symptoms may vary over time and patients generally present with more than one of the typical symptoms of wheeze, cough, shortness of breath and chest tightness. Caregivers are usually concerned about cough and clearly audible airway sounds (usually stertor): these are present in almost every childhood airway disease. The clinician should seek details that would indicate episodes of variable airflow limitation, although doing so can be difficult when obtaining a history across cultural, language and perceptual barriers – the clinician must often demonstrate and explain and confirm understanding before accepting the history as being correctly understood. Episodes of variable airflow limitation are associated with episodes of increased work of breathing, prolonged expiration and a soft expiratory wheeze. A simple squeaky toy can go a long way to demonstrating these features to a caregiver for confirmation. The associated cough is usually a dry cough that may occasionally be more prominent during the early morning hours and be triggered by exercise, cold air, viral infections and exposure to airway irritants and allergens. Asthma is seldom a disease of chronic cough alone: a chronic wet cough, worse at night and during exercise and with clearly audible airway noises without variable airflow limitation, is seldom indicative of asthma.

The frequency, severity and response to bronchodilator therapy also helps an asthma diagnosis. Events that occur more frequently, last longer and respond to a correctly administered bronchodilator raise the probability of an asthma diagnosis.

STEP 2: CONFIRM EPISODES OF VARIABLE AIRFLOW LIMITATION

The second step towards an asthma diagnosis is to confirm episodes of variable airflow limitation. Objective testing for asthma is important.[1] Children are often not symptomatic at the time of the clinical examination, and hyperinflation and wheeze at the time of the examination must be seen as a golden opportunity to seek variable EFL. This is the opportunity to focus specifically on the findings of prolonged or forced expiration, wheeze and hyperinflation and to administer a rapid-acting bronchodilator (pressurised metered-dose inhaler (pMDI) via a spacer device) correctly. The patient should be re-examined after 15–20 minutes. An improvement in the clinical features of wheeze, prolonged expiration and hyperinflation will support variable EFL and an asthma diagnosis. The more you search for variable airflow limitation and do not find it, the more likely it is not asthma. Importantly the more you look out for variable EFL and establish that this is in fact present, the more likely it is due to asthma.

There are objective diagnostic tools such as spirometry and peak expiratory flow measurements with which to confirm variable EFL. Spirometry is preferred but will most likely not be accessible in resource-limited environments. Peak expiratory flow measurements (PEFR) are often problematic, but more readily available; however, they should still be pursued where possible. A PEFR improvement of more than 15% after administering a rapid-acting bronchodilator or a fall of more than 15% after 6 minutes of strenuous exercise (target heart rate of 0.8 x 220 minus the age in years) or variations of >20% between

TABLE I: CONDITIONS THAT MAY MIMIC ASTHMA[13]

INFECTIVE	STRUCTURAL	FUNCTIONAL
Bronchiolitis	Tracheo- & bronchomalacia	Wheeze phenotypes
Atypical airway infection	Tracheal webs, tracheal & bronchial stenosis	Primary ciliary dyskinesia
Bacterial airway infection	Lymphadenopathy & tumors	Cystic fibrosis
Laryngotracheobronchitis	Vascular compression: • Double aortic arch • Innominate artery • Left pulmonary artery sling • Ductus arteriosus ligament • Cardiac chamber or pulmonary artery enlargement	Gastro-oesophageal reflux disease
Protracted bacterial bronchitis	Cystic lesions & masses	Retained foreign body
	H-type tracheo-oesophageal fistula	Pulmonary oedema or cardiac disease
	Laryngeal cleft	Interstitial (diffuse) pulmonary disease
		Bronchiolitis obliterans
		Bronchopulmonary dysplasia
		Bronchiectasis
		Immunodeficiency
		Vocal cord adduction
		Sighing dyspnoea
		Perceived tight chest
		Exercise-induced laryngeal obstruction

outpatient visits (using the same peak-flow meter) will warn of variable airflow limitation. An increase in the PEFR of >20% after four weeks of regular controller treatment is also a useful indicator. There should be a drive for training in spirometry and PEFR in resource-limited settings and for them both to be made more available in such settings.[6]

STEP 3: ASCERTAIN THE NATURE OF THE UNDERLYING AIRWAY INFLAMMATION

The third step towards an asthma diagnosis is to form an opinion on the nature of the underlying airway inflammation. Many airway diseases are associated with airway inflammation. Protracted bacterial bronchitis is a good example. Here, neutrophil-dominated inflammation can mimic asthma. Many asthmatic children suffer from Type-2 inflammation of their airways: it is characterised by antigen-specific IgE, eosinophilia and Type-2 inflammatory mediators. It is often associated with the clinical features of allergy.

The clinical examination should focus on finding typical features of allergic disease such as AD and allergic rhinitis (AR). The markers of Type-2 inflammation (such as sputum or peripheral eosinophilia and a demonstration of antigen-specific IgE) may be demonstrated in a resource-limited setting through available laboratory investigations such as a blood count and with allergen skin-prick testing (SPT). SPT can be performed in the consultation room and there should also be a drive towards greater availability of SPT in resource-limited settings, and training in SPT.

In practice, few children with asthma have non-Type-2 inflammation. Those children who do have it respond poorly to correctly administered inhaled corticosteroid (ICS).

All children who are considered for an asthma diagnosis should therefore always receive an initial trial of low-dose inhaled corticosteroid (ICS) before a decision is taken about continuous use. The ICS should be correctly administered with a pMDI and a spacer device over an initial 6–8-week period. The symptoms should improve. The ICS should then be discontinued and restarted only if symptoms recur.

STEP 4: CONSIDER CONDITIONS THAT MIMIC ASTHMA

The last step towards an asthma diagnosis is to consider those conditions that mimic asthma. The symptoms of asthma are not unique to asthma, and so it is easy to confuse asthma with an extensive list of other conditions that may mimic asthma (see Table I). The clinical examination must also serve to seek and exclude a possible alternative diagnosis. Features such as growth faltering, digital clubbing, abnormal cardiovascular findings and unilateral adventitious chest sounds should warn against an asthma diagnosis.

EFFECTIVELY MANAGING ASTHMA WITH LIMITED RESOURCES

It is possible to manage most asthmatic children very effectively without advanced technologies and expensive resources: basic interventions can significantly reduce the morbidity and mortality of asthma and improve QoL.

EDUCATION

Education is key. Caregivers and patients must understand why

they need to adhere to specific aspects of their management. Healthcare workers must be prepared to teach. A good teacher is one who does not only explain but also demonstrates and inspires. Limited resources are often wasted through ineffective communication.

CONTROLLER MEDICATION

The key to asthma control is the correct prescription, effective pulmonary delivery and regular administration of controller medication.

ICS treatment undoubtedly offers the best efficacy and best value in all settings. It reduces the frequency and severity of asthma symptoms, asthma exacerbations and the risk of death.[6,8] Children are corticosteroid-sensitive and almost all asthmatic children will be well controlled on low doses of ICS.[14] ICS must be prescribed at the lowest effective daily dose to achieve control and should also be increased in good time to treat any worsening of asthma symptoms and asthma exacerbations.[8]

Persistent mild and moderate severity asthma must be treated with continuous low to medium doses of ICS. Patients who fail to achieve control on lower doses of maintenance ICS must be examined for an alternative diagnosis, an untreated comorbidity or factors outside of the airway such as failed inhaler adherence or technique. The continuing use of higher doses of ICS is discouraged and patients who need ongoing higher doses of ICS to achieve control should be referred to a referral centre for further investigation.

The use of a second controller (such as long-acting bronchodilators, montelukast or tiotropium) is generally not available in resource-limited settings; and the need for a second or even a third controller should also prompt referral to a referral centre.

RELIEVER MEDICATION

Reliever medication must be taken early during asthma exacerbations. Exacerbations often manifest initially as just a worsening of symptoms and then progress to become more severe. Patients must be educated to identify and self-manage exacerbations early.

Exacerbations warn of a lack of controller therapy. Since 2019, the Global Initiative for Asthma (GINA) guidelines no longer recommend the use of pure reliever therapy without any background controller anti-inflammatory medication. Controller therapy should either be applied continuously daily or used intermittently together with reliever medication during times of flares.

Recent updates to the South African and international asthma guidelines include additional ICS (in combination with rapid-acting bronchodilators) as reliever medication.[6,8] As an example, children with intermittent asthma should no longer receive only a rapid-acting bronchodilator as needed but also a well-timed short course of low-dose ICS together with the bronchodilator. The use of additional ICS as part of reliever therapy is encouraged in all age groups and at all levels of asthma severity.[8] Oral corticosteroid rescue medication should be reserved for progressing and more severe exacerbations where the administration of additional ICS is hampered by compromised airway calibre.

PULMONARY DELIVERY OF MEDICATION

The topical delivery of asthma medication is always preferred to oral medication. This includes reliever as well as controller medication which can easily be administered in resource-limited settings. Controller and reliever medications are available in affordable corticosteroid and rapid-acting bronchodilator pMDI formulations. Seldom should it be necessary to have more than these treatments available, but it is essential to always administer a pMDI via a spacer device, even in adult patients. Older patients can be taught to use a pMDI without a spacer, but it should be noted that pulmonary delivery often fails and asthma control falters in most adult patients who use pMDIs without an attached spacer device.[15]

The best spacer device will offer a breathing valve and a mouthpiece. A mask should be attached for use in children under three years of age. It is important to do away with the mask by three or, at the latest, four years of age as masks reduce pulmonary delivery due to an increased dead-space volume and the nasal deposition (inhalation) of the medication. Effective spacer devices can be home-made with a 500 mL plastic bottle[16] and affordable options such as the Afrispacer®.

'ASSESS-ADJUST-REVIEW' CYCLE

Follow an 'assess-adjust-review' cycle to confirm asthma control and minimise asthma risk.[6,8] Asthma is a chronic condition and therefore patients should not leave without an appointment for their next visit:

- Each visit should be used to assess the level of asthma control[6,13] over the prior four weeks and to form an opinion on the risk for asthma- or medication-related risk.
- Adjustments must be made in accordance with the level of control and risk. These adjustments may involve prescription changes but instead they often involve changes to factors 'outside of the airway'.
- A review of the diagnosis, treatment of co-morbidities, changes to inhaler technique and adherence, or of the need to deal with social factors. It is only through a review of our adjustments that we will be able to confirm control and risk management.

'DIFFICULT-TO-TREAT' AND 'TREATMENT-RESISTANT' ASTHMA

Identify the child who suffers from 'difficult-to-treat' and/or 'treatment-resistant' asthma and refer them. A small percentage of children will not be well controlled despite optimised basic treatment. It is the need for frequent reliever medication, for higher doses of maintenance ICS or for repeated doses of oral corticosteroids that should ring alarm bells.

The disconnection between expectation and outcome should alert the treating doctor to the possibility of a difficult-to-treat or even a treatment-resistant asthma phenotype. In such a case, it is key to get the basics right first:

- Re-confirm the diagnosis. Is it really asthma? Is it not one of the mimickers of asthma? (see Table I)
- Ensure that the reason for the poor control does not lie 'outside of the airway', as in the case of asthma plus co-

morbidities, incorrect inhaler technique or non-adherence for whatever reason.[14]

Treatment-resistant asthma is a sub-group of the difficult-to-treat group and is effectively a retrospective diagnosis. These children should have access to a specialist referral centre for further investigation.

CONCLUSION

Asthma can and must be diagnosed and managed effectively. Indeed, it is our duty to do so. Resource limitation will be a reality for our lifetime, but it cannot be accepted as an excuse for failed asthma management. Four simple diagnostic steps, accessible treatment options, follow-up visits and proper asthma education will benefit asthmatic patients – even those who rely on resource-limited healthcare. It is our duty to understand and teach asthma to healthcare workers and to patients. It is the duty of healthcare providers to ensure a minimum of ICS, rapid-acting bronchodilators, simple spacer devices, basic special investigations and a referral path for those patients who do not achieve asthma control with these basic measures. It is clearly only good partnerships between patients, healthcare workers and the providers of healthcare that will facilitate and ensure proper asthma care in resource-limited settings.

DIAGNOSE AND MANAGE ASTHMA EFFECTIVELY WITH LIMITED RESOURCES: KEY POINTS

1. Healthcare providers must be competent in understanding the diagnosis and management of asthma.
2. Healthcare providers must be equipped to educate patients.
3. Low- and medium-strength ICS pMDIs must be available for regular control and for timeous additional doses when reliever therapy is indicated.
4. Rapid-acting bronchodilator pMDIs must be available when reliever therapy is needed; they should not be used without additional ICS.
5. Paediatric and adult patients should always use pMDIs through a spacer device. A spacer device without a mask must be used by children from the age of 3–4 years.
6. Patients should receive 4–6 monthly (or as needed) follow-up visits to assess, review and adjust their treatment.
7. Healthcare providers must identify patients who fail to control asthma or who are at risk of complications (difficult-to-treat and treatment-resistant asthma), then get the basics right and refer the individual to a higher level of care if needed.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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