Asthma: An update on diagnosis and management for the African Clinician

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Professor, University of Douala
Objectives

• Definition & epidemiology
• Main features of pathophysiology
• Diagnosis asthma
• Assessment asthma
• Treatment of asthma
Definition

• Asthma is a heterogeneous disease, usually characterized by chronic airway inflammation. It is defined by the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness and cough that vary over time and in intensity, together with variable expiratory airflow limitation.

• Airflow limitation may later become persistent
Clinical phenotypes

• **Allergic asthma**: commences in childhood, eosinophilic airway inflammation
• **Non-allergic asthma**: the sputum of these patients may be neutrophilic,
• **Adult-onset (late-onset) asthma**: non-allergic,
• **Asthma with persistent airflow limitation**: airflow limitation that is persistent or incompletely reversible.
• **Asthma with obesity**: some obese patients with asthma little eosinophilic airway inflammation.

Epidemiology

- 339 million people worldwide affected by asthma

Figure 1: Prevalence of asthma symptoms among 13-14 year olds (ISAAC).

Epidemiology

• 339 million people worldwide affected by asthma

GBD Study 2016. Lancet 2017; 390

Ait-Khaled N. Allergy 2007;62
Epidemiology

New Asthma survey (2017-2020)
135 countries,
353 sites

Figure: Global Asthma Network Centres at June 2018.
Epidemiology

Figure 2:

Challenges of asthma in LMICs

- Poor access to essential asthma medicines,
- Lack of well-organised health services that can provide long-term care,
- Lack of Standard Case Management,
- Insufficiency of well-trained health professionals,
- Lack of adequate information systems
Risk factors for the development of asthma
Predisposing causes
• Atopy
• Gender

Causative factors
• Indoor allergens
  House dust mites
  Animal allergens
  Molds
• Outdoor allergens
  Pollens
  Molds
  Insects
• Aspirin (NSAIDs)²
• Occupational sensitizing agents

Contributing factors*
• Respiratory infection
• Diet
• Air pollution
  Outdoor pollutants
  Indoor pollutants

• Smoking
  Passive smoking
  Active smoking
• Parasitic infection

Risk factors for acute exacerbation in asthmatic patients
• Allergens
• Respiratory infection
• Exercise and hyperventilation
• Weather
• Sulfur dioxide
• Food products, food additives
• Alcohol
• Drugs
• Psychological stress
• Overwork
• Menstruation
Pathophysiology

Allergen

Macrophage/Dendritic cell

Th2 cell

Mast cell

Eosinophil

Neutrophil

Mucus plug

Nerve activation

Epithelial shedding

Subepithelial fibrosis

Sensory nerve activation

Cholinergic reflex

Vasodilatation

Plasma leak

Edema

New vessels (angiogenesis)

Mucus hypersecretion

Hyperplasia

Airway smooth muscle

Bronchoconstriction

Hypertrophy/hyperplasia

Source: Peter J. Barnes, MD
Pathophysiology

Allergens
Sensitizers
Viruses
Air pollutants?

INFLAMMATION
‘Chronic eosinophilic bronchitis

AIRWAY HYPERRESPONSIVENESS

SYMPTOMS
Cough  Wheeze
Chest  Dyspnea

TRIGGERS
Allergens
Exercise
Cold air
SO₂
Particulates

Source: Peter J. Barnes, MD
Pathophysiology

**Inflammatory cells**
- Mast cells
- Eosinophils
- Th2 cells
- Basophils
- Neutrophils
- Platelets

**Structural cells**
- Epithelial cells
- Sm muscle cells
- Endothelial cells
- Fibroblast
- Nerves

**Mediators**
- Histamine
- Leukotrienes
- Prostanoids
- PAF
- Kinins
- Adenosine
- Endothelins
- Nitric oxide
- Cytokines
- Chemokines
- Growth factors

**Effects**
- Bronchospasm
- Plasma exudation
- Mucus secretion
- AHR
- Structural changes

Source: Peter J. Barnes, MD
Increased probability of asthma if:

- At least 2 of these symptom: wheeze, shortness of breath, cough, chest tightness
  - Symptoms often worse at night or in the early morning
  - Symptoms vary over time and in intensity
  - Symptoms are triggered by viral infections, exercise, allergen exposure, changes in weather, irritants (fumes, smoke, or strong smells)
- Family History of asthma, allergic rhinitis,
Diagnosis of asthma – symptoms

*Less likely to suggest asthma if:*

- Isolated cough with no other respiratory symptoms
- Chronic production of sputum
- Shortness of breath associated with dizziness, light-headedness or peripheral tingling
- Chest pain
Diagnosis of asthma

• Physical examination in people with asthma
  • Often normal
  • The most frequent finding is wheezing on auscultation

• Wheezing may be absent during severe asthma exacerbations (‘silent chest’)

• Wheezing is also found in other conditions (Respiratory infections, COPD, Upper airway dysfunction, Endobronchial obstruction, Inhaled foreign body)
Spirometry: variable airflow limitation

• Confirm airflow limitation
  • FEV$_1$/FVC is reduced (when FEV$_1$ is low)
  • FEV$_1$/FVC ratio is normally $>0.75$ – $0.80$ in healthy adults

• Confirm variation in lung function
  • Excessive bronchodilator reversibility (adults: increase in FEV$_1$ $>12\%$ and $>200$mL)
  • Significant increase in FEV$_1$ by $>12\%$ and $>200$ mL (or PEF by $>20\%$) after 4 weeks of controller treatment

Note: Each FEV$_1$ represents the highest of three reproducible measurements.
Assessment of asthma

- Assess asthma control
- Assess treatment issues
- Assess comorbidities
Assessment of asthma

Assessment of symptom control and future risk of adverse outcomes

- Assess symptom control over the last 4 weeks

<table>
<thead>
<tr>
<th>Symptom control</th>
<th>Well-controlled</th>
<th>Partly controlled</th>
<th>Uncontrolled</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the past 4 weeks, has the patient had:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Daytime asthma symptoms more than twice a week?</td>
<td>Yes☑️ No☒</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Any night waking due to asthma?</td>
<td>Yes☑️ No☒</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Reliever needed for symptoms* more than twice a week?</td>
<td>Yes☑️ No☒</td>
<td>None of these</td>
<td>1-2 of these</td>
</tr>
<tr>
<td>• Any activity limitation due to asthma?</td>
<td>Yes☑️ No☒</td>
<td>3-4 of these</td>
<td></td>
</tr>
</tbody>
</table>
Assessment of asthma: risk factors

Risk factors for exacerbations include:

• Ever intubated for asthma
• Uncontrolled asthma symptoms
• Having ≥1 exacerbation in last 12 months
• Low FEV₁ (measure lung function at start of treatment, at 3-6 months to assess personal best, and periodically thereafter)
• Incorrect inhaler technique and/or poor adherence
• Smoking
• Obesity, pregnancy, blood eosinophilia

Risk factors for fixed airflow limitation include:

• No ICS treatment, smoking, occupational exposure, mucus hypersecretion, blood eosinophilia

Risk factors for medication side-effects include:

• Frequent oral steroids, high dose/potent ICS
Assessment of asthma

Assess asthma control: symptom control and future risk of adverse outcomes
- Assess symptom control over the last 4 weeks
- Assess risk factors for poor outcomes, including low lung function

Assess treatment issues
- Check inhaler technique and adherence
- Ask about side-effects
- Does the patient have a written asthma action plan?
- What are the patient’s attitudes and goals for their asthma?

Assess comorbidities
- Think of rhinosinusitis, GERD, obesity, obstructive sleep apnea, depression, anxiety
- These may contribute to symptoms and poor quality of life

https://ginasthma.org
Assessing asthma severity

- Retrospectively from the level of treatment required to control symptoms and exacerbations.
- It can be assessed once the patient has been on controller treatment for several months and,
- Asthma severity is not a static feature and may change over months or years.
Assessing asthma severity

- **Mild asthma**: well controlled with as-needed ICS-formoterol alone, or with low dose ICS (Step 1 or Step 2 treatment).

- **Moderate asthma**: well controlled with low or medium dose ICS-LABA (Step 3 or Step 4 treatment).

- **Severe asthma**: remains ‘uncontrolled’ despite optimized treatment with high dose ICS-LABA, or that requires high dose ICS-LABA to prevent it from becoming ‘uncontrolled’.
Treatment of asthma

Goals of asthma management

• achieve good symptom control, and
• to minimize future risk of asthma-related mortality, exacerbations, persistent airflow limitation and side-effects of treatment.
Treatment of asthma

The patient-health care provider partnership

• Effective asthma management requires the development of a partnership between the person with asthma (or the parent) and health care providers

• This should enable the asthma patient to gain the knowledge and skills to assume a major role in the management of their asthma.

• Self-management education reduces asthma morbidity in both adults

• This partnership needs to be individualized to each patient

https://ginasthma.org
Treatment of asthma

• **Controller medications:**
  - Inhaled corticosteroids: beclomeetasone, budesonide, fluticasone,
  - Association ICS-Long acting B-agonists: béclométasone- formotérol, budésonide- formotérol, fluticasone- formotérol, fluticasone-salméterol

• **Add-on therapies** for patients with severe asthma: Long-acting muscarinic antagonists (LAMA), antagonist of leukotrienes

• **Reliever medications:** include as-needed low dose ICS-formoterol or as-needed SABA

https://ginasthma.org
### Existence of an Essential Medicine List and National Reimbursement List, and inclusion.

<table>
<thead>
<tr>
<th></th>
<th>High-Income Countries and Territories (41)</th>
<th>Low- and Middle-Income Countries (70)</th>
<th>Total N (%)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Essential Medicines List (EML)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have EML</td>
<td>22 (54)</td>
<td>68 (97)</td>
<td>90 (81)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Any inhaled corticosteroid (ICS)</td>
<td>18 (82)</td>
<td>53 (78)</td>
<td>71 (79)</td>
<td>0.7</td>
</tr>
<tr>
<td>Salbutamol</td>
<td>19 (86)</td>
<td>59 (87)</td>
<td>78 (87)</td>
<td>0.9</td>
</tr>
<tr>
<td>Beclomethasone 50 μg</td>
<td>15 (68)</td>
<td>38 (55)</td>
<td>53 (59)</td>
<td>0.3</td>
</tr>
<tr>
<td>Beclomethasone 100 μg</td>
<td>16 (73)</td>
<td>31 (46)</td>
<td>47 (52)</td>
<td>0.03</td>
</tr>
<tr>
<td>Budesonide 100 μg</td>
<td>9 (41)</td>
<td>17 (25)</td>
<td>26 (29)</td>
<td>0.2</td>
</tr>
<tr>
<td>Budesonide 200 μg</td>
<td>12 (55)</td>
<td>24 (35)</td>
<td>36 (40)</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>National Reimbursement List (NRL)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have NRL</td>
<td>35 (85)</td>
<td>46 (66)</td>
<td>81 (73)</td>
<td>0.02</td>
</tr>
<tr>
<td>Any ICS</td>
<td>33 (94)</td>
<td>32 (70)</td>
<td>65 (80)</td>
<td>0.006</td>
</tr>
<tr>
<td>Salbutamol</td>
<td>33 (94)</td>
<td>37 (80)</td>
<td>70 (86)</td>
<td>0.07</td>
</tr>
<tr>
<td>Beclomethasone 50 μg</td>
<td>30 (86)</td>
<td>23 (50)</td>
<td>53 (65)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Beclomethasone 100 μg</td>
<td>29 (83)</td>
<td>20 (43)</td>
<td>49 (60)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Budesonide 100 μg</td>
<td>18 (51)</td>
<td>15 (33)</td>
<td>33 (41)</td>
<td>0.9</td>
</tr>
<tr>
<td>Budesonide 200 μg</td>
<td>21 (60)</td>
<td>24 (52)</td>
<td>45 (56)</td>
<td>0.5</td>
</tr>
<tr>
<td>Any ICS and Salbutamol</td>
<td>32 (91)</td>
<td>31 (67)</td>
<td>63 (78)</td>
<td>0.01</td>
</tr>
</tbody>
</table>
Treatment of asthma

How to initiate the controller treatment

• ICS-containing controller treatment should be initiated as soon as possible after the diagnosis of asthma is made, as the evidence suggests that:
  o Early initiation of low dose ICS in patients with asthma leads to a greater improvement in lung function
  o Patients not taking ICS who experience a severe exacerbation have a greater long-term decline in lung function than those who have already started ICS

https://ginasthma.org
LABA: long-acting beta₂-agonist; LAMA: long-acting muscarinic antagonist; MART: maintenance and reliever therapy with ICS-formoterol; OCS: oral corticosteroids

START HERE IF:

CONTROLLER and PREFERRED RELIEVER (Track 1). Using ICS-formoterol as reliever reduces the risk of exacerbations compared with using a SABA reliever.

CONTROLLER and ALTERNATIVE RELIEVER (Track 2). Before considering a regimen with SABA reliever, check if the patient is likely to be adherent with daily controller therapy.

RELIEVER: As-needed low-dose ICS-formoterol

RELIEVER: As-needed short-acting β2-agonist

https://ginasthma.org
**Step 1/2:**

- **Initial treatment**
- **Stepdown the treatment from step 2**

### STEPS 1 – 2

**As-needed low dose ICS-formoterol**

### RELIEVER: As-needed short-acting β2-agonist

### STEPS 1

**Take ICS whenever SABA taken**

### RELIEVER: As-needed short-acting β2-agonist

### STEPS 2

**Low dose maintenance ICS**

### RELIEVER: As-needed short-acting β2-agonist

### STEPS 3

**Low dose maintenance ICS-formoterol**

### RELIEVER: As-needed low-dose ICS-formoterol

### STEPS 4

**Medium dose maintenance ICS-LABA**

### RELIEVER: As-needed short-acting β2-agonist

### STEPS 5

**Add-on LAMA**

Refer for phenotypic assessment ± anti-IgE, anti-IL5/5R, anti-IL4R

Consider high dose ICS-formoterol

**Add-on LAMA**

Refer for phenotypic assessment ± anti-IgE, anti-IL5/5R, anti-IL4R

Consider high dose ICS-LABA

**Add LAMA or LTRA, or add high dose ICS**

**Add azithromycin (adults) or LTRA; add low dose OCS but consider side-effects**
### Step 3

<table>
<thead>
<tr>
<th>STEPS 1 – 2</th>
<th>RELIEVER: As-needed low-dose ICS-formoterol</th>
</tr>
</thead>
<tbody>
<tr>
<td>As-needed low dose ICS-formoterol</td>
<td></td>
</tr>
</tbody>
</table>

### Controller and Preferred Reliever

(Track 1). Using ICS-formoterol as reliever reduces the risk of exacerbations compared with using a SABA reliever.

### Controller and Alternative Reliever

(Track 2). Before considering a regimen with SABA reliever, check if the patient is likely to be adherent with daily controller.

### Step 1

**Controller**

Take ICS whenever SABA taken

**Reliever**

As-needed short-acting β2-agonist

### Step 2

**Controller**

Low dose maintenance ICS

**Reliever**

As-needed short-acting β2-agonist

### Step 3

**Controller**

Medium dose maintenance ICS-formoterol

**Reliever**

As-needed low-dose ICS-formoterol

### Step 4

**Controller**

Medium dose maintenance ICS-LABA

**Reliever**

As-needed short-acting β2-agonist

### Step 5

**Controller**

Add-on LAMA

Refer for phenotypic assessment ± anti-IgE, anti-IL5/5R, anti-IL4R

Consider high dose ICS-formoterol

**Reliever**

As-needed short-acting β2-agonist

**Other controller options for either track**

- Low dose ICS whenever SABA taken, or daily LTRA, or add HDM SLIT
- Medium dose ICS, or add LTRA, or add HDM SLIT
- Add LAMA or LTRA, or switch to high dose ICS
- Add azithromycin (adults) or LTRA; add low dose OCS but consider side-effects
### Step 4

**Controller and Preferred Reliever**
(Track 1). Using ICS-formoterol as reliever reduces the risk of exacerbations compared with using a SABA reliever.

<table>
<thead>
<tr>
<th>STEPS 1 – 2</th>
<th>RELIEVER: As-needed low-dose ICS-formoterol</th>
</tr>
</thead>
<tbody>
<tr>
<td>As-needed low dose ICS-formoterol</td>
<td></td>
</tr>
</tbody>
</table>

**Controller and Alternative Reliever**
(Track 2). Before considering a regimen with SABA reliever, check if the patient is likely to be adherent with daily controller.

<table>
<thead>
<tr>
<th>STEP 1</th>
<th>RELIEVER: As-needed short-acting β2-agonist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take ICS whenever SABA taken</td>
<td></td>
</tr>
</tbody>
</table>

**Other controller options for either track**

<table>
<thead>
<tr>
<th>Low dose ICS whenever SABA taken, or daily LTRA, or add HDM SLIT</th>
<th>Medium dose ICS, or add LTRA, or add HDM SLIT</th>
<th>Add LAMA or LTRA, or switch to high dose ICS</th>
<th>Add azithromycin (adults) or LTRA; add low dose OCS but consider side-effects</th>
</tr>
</thead>
</table>

**Step 4**

- Medium dose maintenance ICS-formoterol

**Step 5**

- Add-on LAMA
  - Refer for phenotypic assessment ± anti-IgE, anti-IL5/5R, anti-IL4R
  - Consider high dose ICS-formoterol
### Step 5

**CONTROLLER and PREFERRED RELIEVER**

(Track 1). Using ICS-formoterol as reliever reduces the risk of exacerbations compared with using a SABA reliever.

**STEPS 1 – 2**
- As-needed low dose ICS-formoterol

**RELIEVER:** As-needed low-dose ICS-formoterol

---

**CONTROLLER and ALTERNATIVE RELIEVER**

(Track 2). Before considering a regimen with SABA reliever, check if the patient is likely to be adherent with daily controller.

**STEP 1**
- Take ICS whenever SABA taken

**RELIEVER:** As-needed short-acting β2-agonist

---

**STEP 4**
- Add-on LAMA
- Refer for phenotypic assessment ± anti-IgE, anti-IL5/5R, anti-IL4R
- Consider high dose ICS-formoterol

**STEP 5**
- Add azithromycin (adults) or LTRA; add low dose OCS but consider side-effects

---

**STEP 2**
- Low dose maintenance ICS

**STEP 3**
- Low dose maintenance ICS-LABA

**STEP 4**
- Medium dose maintenance ICS-LABA

**STEP 5**
- Medium dose maintenance ICS-formoterol
Treatment using steps

Symptoms
Exacerbations
Side-effects
Lung function
Patient (and parent) satisfaction

Confirmation of diagnosis if necessary
Symptom control & modifiable risk factors (including lung function)
Comorbidities
Inhaler technique & adherence
Patient (and parent) preferences and goals

Treatment of modifiable risk factors and comorbidities
Non-pharmacological strategies
Asthma medications (adjust down/up/between tracks)
Education & skills training
## Inhaled corticosteroids

### Adults and adolescents (12 years and older)

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
<th>Total daily ICS dose (mcg) – see notes above</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Beclometasone dipropionate (pMDI, standard particle, HFA)</td>
<td>200-500</td>
</tr>
<tr>
<td>Beclometasone dipropionate (DPI or pMDI, extrafine particle, HFA)</td>
<td>100–200</td>
</tr>
<tr>
<td>Budesonide (DPI, or pMDI, standard particle, HFA)</td>
<td>200–400</td>
</tr>
<tr>
<td>Ciclesonide (pMDI, extrafine particle, HFA)</td>
<td>80–160</td>
</tr>
<tr>
<td>Fluticasone furoate (DPI)</td>
<td>100</td>
</tr>
<tr>
<td>Fluticasone propionate (DPI, or pMDI, standard particle, HFA)</td>
<td>100–250</td>
</tr>
<tr>
<td>Mometasone furoate (DPI)</td>
<td>Depends on DPI device – see product information</td>
</tr>
<tr>
<td>Mometasone furoate (pMDI, standard particle, HFA)</td>
<td>200-400</td>
</tr>
</tbody>
</table>
Non pharmacological treatment

- Cessation of smoking
- Encourage people with asthma to engage in regular physical activity for its general health benefits (improves cardiopulmonary fitness).
- Avoidance of occupational exposures
- Avoidance of outdoor air pollutants/weather conditions (very cold weather)
- Reduce indoor allergens (dust mites, molds...)
- Weight reduction
Non pharmacological treatment

• Encourage patients to identify goals and strategies to deal with emotional stress if it makes their asthma worse
• Encourage patients with asthma to consume a diet high in fruit and vegetables for its general health benefits
• Avoidance of medications that may make asthma worse (non-steroidal anti-inflammatory drugs, beta-blokers)
• Check inhaler technique and adherence to treatment
Asthma Action Plan

Name: ____________________________ Date: ____________________________

Doctor: ____________________________ Medical Record #: ____________________________

Doctor's Office Phone #: Day: ____________________________ Night/Weekend: ____________________________

Emergency Contact: ____________________________

Doctor's Signature: ____________________________

**GO**

You have all of these:
- Breathing is good
- No cough or wheeze
- Sleep through the night
- Can work and play

Peak flow from _______ to _______

**CAUTION**

You have any of these:
- First signs of a cold
- Exposure to known trigger
- Cough = thin mucus
- Night cough
- Coughing at night

Peak flow from _______ to _______

**DANGER**

Your asthma is getting worse fast:
- Medicine is not helping
- Breathing is hard and fast
- Noise opens wide
- Rales hear
- Can't talk well

Peak flow reading below

**Use these daily preventive anti-inflammatory medicines:**

<table>
<thead>
<tr>
<th>MEDICINE</th>
<th>HOW MUCH</th>
<th>HOW OFTEN/WHEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>__________</td>
<td>__________</td>
<td>________________</td>
</tr>
</tbody>
</table>

For asthma with symptoms, take:

**Continue with green zone medicine and add:**

<table>
<thead>
<tr>
<th>MEDICINE</th>
<th>HOW MUCH</th>
<th>HOW OFTEN/WHEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>__________</td>
<td>__________</td>
<td>________________</td>
</tr>
</tbody>
</table>

**CALL YOUR PRIMARY CARE PROVIDER.**

**Take these medicines and call your doctor now.**

<table>
<thead>
<tr>
<th>MEDICINE</th>
<th>HOW MUCH</th>
<th>HOW OFTEN/WHEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>__________</td>
<td>__________</td>
<td>________________</td>
</tr>
</tbody>
</table>

GET HELP FROM A DOCTOR NOW! Do not be afraid of seeking a face. Your doctor will want to see you right away. It’s important! If you cannot contact your doctor, go directly to the emergency room. DO NOT WAIT.

Make an appointment with your primary care provider within two days of an ER visit or hospitalization.
Conclusion

- Asthma is an increasing major health problem in Africa

- Governments in Africa should increase political commitment by adopting all components of standard care management

  - National asthma control Programme
  - Asthma diagnosis & management guidelines
  - Patient education
  - Appropriate training of healthcare workers
  - Uninterrupted supply of affordable essential asthma medicines
Dr Sandra Kwarteng Owusu

PATS SYMPOSIUM 12-05-2021

Paediatric Pulmonologist
Department of Child Health
Komfo Anokye Teaching Hospital Kumasi
Outline of Presentation

• Definition of asthma
• Issues of Childhood Asthma in Africa
• Making a diagnosis of asthma in a child
  Important aspect of History taking
  Important and aspect of Physical Examination
• Initial communication of asthma diagnosis with the family
• Initiating Pharmacotherapy
Current definition of asthma

• Heterogeneous and genetically complex airways disease with multiple phenotypes
• Characterised by chronic airway inflammation.
• Umbrella term to used to describe a clinical spectrum of diseases that manifests with wheeze, breathlessness, chest tightness and cough worse at night.
• These symptoms results from recurrent and reversible airways obstruction.

Asthma Commission Lancet 2017
GINA 2020
Asthma in Africa messages from-ISAAC

- Prevalence of asthma in childhood is approximately 10%, and continues to rise, largely driven by urbanization.

- In Lower Middle Income Countries (LMIC)
  1. Asthma diagnosis may be delayed
  2. Asthma may be missed diagnosed
  3. Poorly treated with worse outcomes

- High incidence of HIV and Tuberculosis and other respiratory infections may hinder the diagnosis of asthma in Africa.

- Lack of resources, not so well established health systems, lack of medications and lack of knowledge about childhood asthma in communities.

Asthma in Africa – where are we now?

- ACACIA study currently ongoing in six African countries will help provide more current information on asthma disease burden, control and barriers in adolescents beyond ISAAC.
Diagnosis of asthma in children—Useful considerations

• One third of all children would have an episode of wheezing at least once before age three.

• Children less than five years are prone to frequently recurring viral upper respiratory tract infections which may be associated with recurrent wheeze.

• Most children will become asymptomatic by school going age.
• Only a quarter will have persistent symptoms and later develop asthma.

White D et al, ALLSA Handbook 2018
Bush et al EMJ 2016
Wheeze in young children is often not due to asthma. Wheeze in older children could be due to asthma. Transient wheezing in infancy is often a function of small airways. Up to two thirds of infant wheezing will resolve by school age.
Making the diagnosis of asthma in children

1. A good history is always helpful to begin with – focus on symptom onset (when first) and progress over time.

2. Who is your patient? understand their background and understand their symptom profile, what did the parents notice?

3. Characteristic pattern/episodes/recurrence of respiratory symptoms
   - Cough worse at night or early morning
   - Wheeze
   - Dyspnea/Shortness of breath and chest
   *Note: these symptoms are not limited to asthma only*

4. Symptoms commonly occur together

5. Resolution of symptoms (interval free periods – reversible expiratory airflow limitation).

GINA 2020
Features suggestive of asthma

1. Variability day and night (nocturnal cough is common, day to day, seasonality)

2. Triggers or Precipitants by a range of factors, environmental allergens exposure, house dust mites, grass pollens, exercise, cold weather, viral infection, smoke, strong smells, dust

3. Objective assessment of response to bronchodilators and corticosteroids

4. Family history of doctor diagnosed asthma in a sibling or parent

5. Presence of symptoms of other atopic conditions, frequently blocked nostrils even outside common colds sneezing, frequent itching and red eyes, dry itchy skin,
Modified Asthma predictive index for children—may be used as a guide— (not validated in Africa)

**MAJOR**
- Parent with Asthma
- Patient with Eczema
- Inhalant Allergen sensitization

**MINOR**
- Allergic Rhinitis
- Wheezing apart from common colds
- Eosinophilia > 4%
- Food Allergen Sensitization
When do you consider alternative diagnosis

- Symptoms onset - very early in life by first month of life
- Patient is growing poorly, failure to thrive - growth charts
- Symptoms are associated with and worsens with feeding
- Vomiting associated with respiratory symptoms
- Patient has isolated cough
- Chronic or persistent wet cough / productive cough
- Stridor that worsens with exercise
- Only chest pain

R Masekela et al, SAMJ 2018
Helpful –the options to consider in “Recurrent Viral Infections” Pulmonary Aspiration Major/ Severe Diseases True Asthma

Bush et al EMJ 2016;1[1]:93-101
Remember the Major conditions

Bush et al. EMJ 2016;1[1]:93-101
Physical examination

- The examination may be normal without much on chest examination or chest examination may reveal wheezes - *bilateral polyphonic*
- However when a child is admitted to the emergency room with an acute exacerbation the diagnosis can be made following response to bronchodilators
- Also look for evidence of allergic conditions
- Examine the nostrils, the skin around the face, neck and other flexures, the eyes
- Allergic facies
- Skin in flexural areas - elbow region and popliteal fossa.
Physical Examination- warning signs

- Digital Clubbing, Lymphadenopathy, Z-scores which are very low
- Upper airway assessment, nasal polyps
- Unusually severe chest deformity
- Severe hypoxaemia at presentation outside exacerbation.
- Asymmetrical signs - unilateral monophonic wheeze
- Sound heard on inspiration - stridor
- Murmurs and other signs of cardiac or systemic diseases,
Differential Diagnosis for the older child 6-111 years

- Foreign Body aspiration- Focal signs
- Vocal Cord Dysfunction-adolescent girls
- Tuberculosis/HIV
- Suppurative lung disease- Bronchiectasis
- Congenital heart disease.
For children older than 6 years offer spirometry: it is the (old) standard for used to support initial diagnosis to establish reversibility and also for management.

Personal Peak flow measurements may be used - one over a 2-week period.
Other Investigations

• Skin prick tests
• Blood or sputum eosinophilia
• Is chest xray helpful- it may rule out other conditions.
Preschool children in Africa - we are still not informed on lung function

Outline
Introduction
Asthma
Bronchiectasis
Lung disease in children born preterm
Human immunodeficiency virus (HIV)
Tuberculosis
Sickle cell disease
Summary and conclusion
Declaration of interest
References

Chronic Lung Disease in Children: disease focused use of lung function

Diane M Gray 1, Sandra Kwarteng Owusu 2, Marieke M van der Zalm 3

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https://doi.org/10.1016/j.cophys.2021.05.001

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Improving lung health in low-income and middle-income countries: from challenges to solutions


Lancet 2021; 397: 928-40
Published Online
February 22, 2021
https://doi.org/10.1016/S0140-6736(21)00458-X
*Joint first authors

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Liverpool School of Tropical Medicine, Liverpool, UK
(J Meghji PhD, Prof K Mortimer PhD); Global Initiative for Asthma (GINA),
Fontana, WI, USA (K Mortimer, Prof E D Bateman MD).

Low-income and middle-income countries (LMICs) bear a disproportionately high burden of the global morbidity and mortality caused by chronic respiratory diseases (CRDs), including asthma, chronic obstructive pulmonary disease, bronchiectasis, and post-tuberculosis lung disease. CRDs are strongly associated with poverty, infectious diseases, and other non-communicable diseases (NCDs), and contribute to complex multi-morbidity, with major consequences for the lives and livelihoods of those affected. The relevance of CRDs to health and socioeconomic wellbeing is expected to increase in the decades ahead, as life expectancies rise and the competing risks of early childhood mortality and infectious diseases plateau. As such, the World Health Organization has identified the prevention and control of NCDs as an urgent development issue and essential to the achievement of the Sustainable Development Goals by 2030. In this Review, we focus on CRDs in LMICs. We discuss the early life origins of CRDs; challenges in their prevention, diagnosis, and management in LMICs; and pathways to solutions to achieve true universal health coverage.
Childhood predictors of lung function trajectories and future COPD risk: a prospective cohort study from the first to the sixth decade of life


Summary

Background Lifetime lung function is related to quality of life and longevity. Over the lifespan, individuals follow different lung function trajectories. Identification of these trajectories, their determinants, and outcomes is important, but no study has done this beyond the fourth decade.

Lancet Respir Med 2018; 6: 535-44
Published Online
Preparing a special generation for the future

Figure 1: Trajectories of lung function (FEV₁, z-score) from 7 to 53 years of age
The six trajectories represent the latent growth patterns of lung function. The group prevalences do not add up to 100% because of rounding.

Figure 2: Prevalence of COPD among six lung function trajectories at 53 years
COPD=chronic obstructive pulmonary disease.
When Diagnosis is made - Plan for long term management

• As soon as a diagnosis is made – educate the family, *(Missed opportunities)*

• Plan for continuous care – Asthma clinic enrollment

• Discuss initiation and adherence to pharmacotherapy (controller) therapy

• Techniques for use of inhalers together with spacer devices *use dummies and let the children practice*

• Talk to family about identifying *triggers and avoidance*

• Look for and manage other associated allergic co-morbidities

• Teach the family -prehospital management of exacerbations *where do they go first for help if home management fails*

• If possible teach them to use an asthma action plan
Set Goals together with the family for long term
Work together-partnership

Impairment
- No Day time symptoms
- Full participation in school activities, don’t completely stop all physical activities
- Aim for no night time symptoms
  restful sleep free from nighttime cough and wheeze

Risks
- Prevent serious attacks and hospitalization
- Have near normal lung function
- Minimal medication side effects
- Normal growth and development

GINA 2020
Eyes on target (inside the airway)

Normal bronchiale

Asthmatic bronchiale

- Smooth muscle
- Spasm
- Swollen mucosa
- Secretions
- Set alight-ness
- Scarring
Two main groups of asthma medications
Inhaled corticosteroids therapy is the main stay for long term asthma management

1. **Controllers (Anti inflammatory effects)** for long term control
   - **G(old)** = Inhaled corticosteroids
   - Adherence, correct technique and age appropriate devices

2. **Reliever (Bronchodilators)** – for acute relief includes short acting beta2 agonists (SABAs) and anticholinergics. *No effect on inflammation*
Plan Periodic reviews together

Box 2-2. GINA assessment of asthma control in adults, adolescents and children 6–11 years

A. Asthma symptom control

<table>
<thead>
<tr>
<th>In the past 4 weeks, has the patient had:</th>
<th>Level of asthma symptom control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Well controlled</td>
</tr>
<tr>
<td>Daytime asthma symptoms more than twice/week?</td>
<td>Yes □ No □</td>
</tr>
<tr>
<td>Any night waking due to asthma?</td>
<td>Yes □ No □</td>
</tr>
<tr>
<td>SABA reliever for symptoms more than twice/week?*</td>
<td>Yes □ No □</td>
</tr>
<tr>
<td>Any activity limitation due to asthma?</td>
<td>Yes □ No □</td>
</tr>
</tbody>
</table>

At each visit listen to them assess the level of control, maintain or adjust the treatment step up or step down

Control is the degree to which the manifestations of asthma symptoms are minimised by treatment

GINA 2020
Initiating Treatment

Children 5 years and younger

**Personalized asthma management:**
Assess, Adjust, Review response

**Asthma medication options:**
Adjust treatment up and down for individual child's needs

<table>
<thead>
<tr>
<th>PREFERRED CONTROLLER CHOICE</th>
<th>STEP 1</th>
<th>STEP 2</th>
<th>STEP 3</th>
<th>STEP 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily low dose inhaled corticosteroid (ICS) (see table of ICS dose ranges for pre-school children)</td>
<td>Daily leukotriene receptor antagonist (LTRA), or intermittent short courses of ICS at onset of respiratory illness</td>
<td>Double 'low dose' ICS</td>
<td>Continue controller &amp; refer for specialist assessment</td>
<td></td>
</tr>
<tr>
<td>Other controller options</td>
<td></td>
<td>Low dose ICS + LTRA Consider specialist referral</td>
<td>Add LTRA, or increase ICS frequency, or add intermittent ICS</td>
<td></td>
</tr>
</tbody>
</table>

**RELIEVER**
As-needed short-acting β<sub>2</sub>-agonist

**CONSIDER THIS STEP FOR CHILDREN WITH:**
Infrequent viral wheezing and no or few interval symptoms
Symptom pattern not consistent with asthma but wheezing episodes requiring SABA occur frequently, e.g. ≥3 per year. Give diagnostic trial for 3 months. Consider specialist referral. Symptom pattern consistent with asthma, and asthma symptoms not well-controlled or ≥3 exacerbations per year
Asthma diagnosis, and asthma not well-controlled on low dose ICS
Asthma not well-controlled on double ICS

**EXCLUDE ALTERNATIVE DIAGNOSES**
Symptom control & modifiable risk factors
Comorbidities
Inhaler technique & adherence
Parent preferences and goals

**TREAT MODIFIABLE RISK FACTORS**
Non-pharmaceutical strategies
Asthma medications
Education & skills training

GINA 2021
# Initiating Treatment

**STARTING TREATMENT**  
Children 6–11 years with a diagnosis of asthma

<table>
<thead>
<tr>
<th><strong>ASSESS:</strong></th>
<th><strong>START HERE IF:</strong></th>
</tr>
</thead>
</table>
| Confirmation of diagnosis  
Symptom control & modifiable risk factors (including lung function) | Symptoms less than twice a month  
Symptoms twice a month or more, but less than daily |
| Comorbidities  
Inhaler technique & adherence  
Child and parent preferences and goals | Symptoms most days, or waking with asthma once a week or more, and low lung function |

### PREFERRED CONTROLLER
To prevent exacerbations and control symptoms

<table>
<thead>
<tr>
<th><strong>STEP 1</strong></th>
<th><strong>STEP 2</strong></th>
</tr>
</thead>
</table>
| Low dose ICS taken whenever SABA taken | Daily low dose inhaled corticosteroid (ICS) (see table of ICS dose ranges for children)  
Consider daily low dose ICS |
| **STEP 3** | **STEP 4** |
| Low dose ICS-LABA, OR medium dose ICS, OR very low dose ICS-formoterol maintenance and reliever (MART) | Medium dose ICS-LABA, OR low dose ICS-formoterol maintenance and reliever therapy (MART). Refer for expert advice  
Add tiotropium or add LTRA |

### RELIEVER
As-needed short-acting beta2-agonist (or ICS-formoterol reliever for MART as above)

---

*Very low dose: BUD-FORM 100/6 mcg  
Low dose: BUD-FORM 200/6 mcg (metered doses)

---

Short course OCS may also be needed for patients presenting with severely uncontrolled asthma
Initiating Treatment

**SUGGESTED INITIAL CONTROLLER TREATMENT**
in CHILDREN 6-11 years with a diagnosis of asthma

**FIRST ASSESS:**
- Confirmation of diagnosis
- Symptom control & modifiable risk factors (including lung function)
- Comorbidities
- Inhaler technique & adherence
- Child and parent preferences and goals

**IF:**
- Symptoms most days, waking at night ≥ once a week and low lung function?

**START WITH:**
- Medium dose ICS-LABA or low dose MART**
  Refer for expert advice

**STEP 4**
- Short course OCS may also be needed for patients presenting with severely uncontrolled asthma

**STEP 3**
- Low dose ICS-LABA or medium dose ICS or very low dose MART**

**STEP 2**
- Symptoms twice a month or more?

**STEP 1**
- Daily low dose ICS

**STEP 1**
- Take ICS whenever SABA taken

*Low dose: BUD-FORM 200/6 mcg; Very low dose: BUD-FORM 100/6 mcg (metered doses)
MART = maintenance and reliever therapy (ICS-formoterol as both maintenance and reliever)
Spacer devices

- All children diagnosed with asthma will need a spacer device to use with their inhalers.
- Increases lung deposition by acting as a holding chamber.
- Reduces local and systemic side effects by retaining the large drug particles that will otherwise be deposited in the throat.
- In emergency management pMDI plus spacer will equal the nebulizer if used correctly.
- Commercially produced spacers and home made ones are both useful.
<table>
<thead>
<tr>
<th></th>
<th>Comorbidities in asthma</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rhinosinusitis</td>
<td>May co-exist with asthma in up to 80% of cases, Nasal polyps are unusual</td>
</tr>
<tr>
<td>2</td>
<td>GORD</td>
<td>Very common 60-80%, patient has GIT symptoms. Investigate appropriately and treat if present. Evidence does not prove anti reflux therapy improves asthma control. Both GORD and rhinosinusitis can make VCD worse</td>
</tr>
<tr>
<td>3</td>
<td>Obesity</td>
<td>A common comorbidity. Look for other respiratory problems associated with Obesity. Not all obese patients have asthma</td>
</tr>
<tr>
<td>5</td>
<td>Personal or family psychological issues</td>
<td>Anxiety related issues, loss of family member, Maternal depression, poor coping skills. Involve a psychologist early</td>
</tr>
<tr>
<td>6</td>
<td>ABPA</td>
<td>IgE - rising levels. Aspergillus specific IgE, skin prick test</td>
</tr>
</tbody>
</table>
Take home messages

1. The prevalence of asthma in Africa continues to rise, driven by urbanization.
2. In childhood asthma diagnosis may delay, maybe poorly treated due to unavailability and cost of medications.
3. Cough, wheeze and shortness of breath commonly occur together in a recurrent pattern.
4. When diagnosis of asthma is made, education and long term care must be instituted early.
5. Long term lung health can be determined in childhood.
6. Inhaled corticosteroids are the G(old) in asthma management, SABA have no anti-inflammatory effects.
7. At every visit assess control, adjust treatment, review inhaler technique and encourage compliance.
8. Look for and manage co-morbidities.
9. Although childhood asthma cannot be cured it can be effectively managed.
Standardization of Spirometry Update 2019

Evaluation of Spirometry regarding acceptability, usability, repeatability, quality grading

Lindsay Zurba 12 June 2021
Declarations

- No financial disclosures
- No conflicts of interest
- ACACIA as a contributor
Key changes

- Indications
- Relative contraindications
- Absolute contraindications
- Spirometer requirements
- Device quality assurance procedures
- Operator training
- Activities before testing
- Expiration / inspiration
- Acceptability and repeatability criteria
- The end of forced expiration
- Test quality grading
- Operator feedback
- Bronchodilator testing
- New grading system (interp)
- Standardised operator feedback
Aims / learning objectives

Address changes from 2005 to 2019 Standard:

1. Acceptability
2. Usability
3. Repeatability
4. Quality Grading
References


1. Acceptability
Acceptability

Definition

- The guideline for checking the performance of each individual blow
- Assessment of the start, rise, peak downward curve and end of test

How to do it

- Assess each blow one by one
- Use the flow volume and volume time graphs
- Use specific numerical quality indicators
<table>
<thead>
<tr>
<th>Where on blow</th>
<th>Exact part of blow</th>
<th>Explanation and specifics guide</th>
<th>F/V and V/T graphs</th>
<th>Values required to be considered acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start of test</td>
<td>1. Start</td>
<td>The worker blows immediately and fast showing no hesitation or false start</td>
<td>Smooth unhesitating start rising vertically from point 0</td>
<td>Extrapolated volume (BEV which is an indication of hesitation or false starting) ≤5% of the FVC or 0.100 L, whichever is greater</td>
</tr>
<tr>
<td></td>
<td>2. Rise to peak</td>
<td>The worker blows with maximal effort in the first instant of the blow</td>
<td>The rise to peak is vertical and upright with no hesitation, artefacts or sloping right</td>
<td>Time to peak must be ≤ 150 ms.</td>
</tr>
<tr>
<td></td>
<td>3. Peak</td>
<td>Should be sharp and tall indicating maximum effort</td>
<td>Must be tall and pointed, not round or flat. Should be without artefact</td>
<td></td>
</tr>
<tr>
<td>Middle of test</td>
<td>4. Downward trial</td>
<td>Should be without cough, leak, tongue in tube, teeth not biting, biting the mouthpiece too hard or glottis closure</td>
<td>The downward trial of the F/V graph should be smooth and continuous without artefact</td>
<td>No cough or glottic closure in the first second of expiration No evidence of an obstructed mouthpiece/spirometer No evidence of leak No evidence of a faulty zero-flow level</td>
</tr>
<tr>
<td>End of test</td>
<td>5. End of forced expiration (EOFE)</td>
<td>The worker blows out completely to residual volume</td>
<td>The flow volume graph should descend gracefully onto the x axis with no drop off</td>
<td>1. Expiratory plateau (≤ 0.025 L in the last 1 s of expiration) 2. Expiratory time ≥ 15 s 3. FVC is within the repeatability tolerance or is greater than the largest prior observed FVC 4. All FVC efforts end at exactly the same place on the V/T graph</td>
</tr>
<tr>
<td></td>
<td>6. Plateau</td>
<td></td>
<td>The volume time graph should reach a plateau or end at the same time repeatedly</td>
<td></td>
</tr>
</tbody>
</table>
Acceptability

Start of test
1. Start from point zero
2. Rise to peak
3. Peak

Middle of test
4. Downward curve

End of test
5. End of forced expiration
6. FIVC - FVC
Acceptability

Rise to peak

Start

Peak

Downward curve

End of forced expiration

FIVC - FVC

End of forced expiration

1

2

3

4

5

6
Changes in acceptability 2005 to 2019

1. Start of test

2005

1. EV
2. “<5% of the FVC or 0.150L, whichever is greater”

2019

1. BEV
   Extrapolated Volume (EV) has been updated to Back Extrapolated Volume (BEV)
2. “<5% of the FVC or 0.100L, whichever is greater”
Ref 2: Supplemental material for Standardization of Spirometry 2019 Update. (Pg 13)
### Changes in acceptability 2005 to 2019

#### 1. Start of test

<table>
<thead>
<tr>
<th>2005</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hesitation time (HT)</td>
<td>Hesitation time (HT)</td>
</tr>
<tr>
<td><strong>1.</strong> Not mentioned</td>
<td><strong>1.</strong> “The hesitation time, defined as the time from the point of maximal inspiration to Time 0, should be 2 seconds or less”</td>
</tr>
</tbody>
</table>
Ref 2: Supplemental material for Standardization of Spirometry 2019 Update. (Pg 18)
Criteria: <5% of the FVC or 0.100 L, whichever is greater

Trial 6: greater than 0.100 L
5% of 2.83 = 0.140 L therefore 0.120 L can be accepted

Trial 4: BEV greater than 0.100 L
5% of 2.65 = 0.130 L therefore 0.190 L cannot be accepted – too high
Changes in acceptability 2005 to 2019

2. Rise to peak

2005
Rise Time (RT)
1. Not mentioned

2019
Rise time (RT)
1. Rise time from 10% to 90% of peak flow should be ≤150 ms (0.15 s)
2. RT not seen on displays and reports. Consider using the PEFT instead.
Changes in acceptability 2005 to 2019

3. Peak

2005

Peak

1. “… the technician should observe that the subject performed the manoeuvre with maximal effort.”

2. “… Individual spirograms are “acceptable” if they are free from Effort that is not maximal throughout…”

2019

Peak

1. Not mentioned

2. Taken care of in start and rise to peak
# Changes in acceptability 2005 to 2019

## 4. Downward curve

<table>
<thead>
<tr>
<th>2005</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Smooth continuous exhalation</td>
<td>1. Must have no evidence of a faulty zero-flow setting</td>
</tr>
<tr>
<td>2. Without coughing during the first second of the manoeuvre or any other cough</td>
<td>2. Must have no cough in the first second of expiration</td>
</tr>
<tr>
<td>3. Without a leak</td>
<td>3. Must have no glottic closure in the first second of expiration</td>
</tr>
<tr>
<td>4. Without an obstructed mouthpiece</td>
<td>4. Must have no glottic closure after 1 s of expiration</td>
</tr>
<tr>
<td>5. Without evidence of an extra breath being taken during the manoeuvre</td>
<td></td>
</tr>
</tbody>
</table>
Changes in acceptability 2005 to 2019

5. End of Forced expiration (EOFE)

2005

FET

1. The volume–time curve shows no change in volume (0.025 L) for ≥1 s, and the subject has tried to exhale for ≥3 s in children aged <10 yrs and for ≥6 s in subjects aged >10 yrs
2. The subject cannot or should not continue further exhalation.

2019

EOFE

1. Redefined from FET to EOFE
2. Expiratory plateau (≤ 0.025 L in the last 1 s of expiration) OR
3. Expiratory time ≥ 15 s OR
4. FVC is within the repeatability tolerance or is greater than the largest prior observed FVC in the same testing session
5. All FVC efforts end at exactly the same place on the V/T graph
Figure 2. Flowchart outlining the end of forced expiration (EOFE) acceptability criteria for FVC. *If there are no prior observed FVC values in the current pre- or post-bronchodilator testing set, then the FVC provisionally meets EOFE acceptability criteria.
End of forced expiration (EOFE)

EOFE is considered acceptable when:
“The patient cannot expire long enough to achieve a plateau”
In this case, the measure of whether EOFE has been reached is for the patient to repeatedly achieve the same FVC.”

(page e78, column 3, paragraph 3)
End of forced expiration (EOFE)

- EOFE is considered acceptable when an expiratory time of 15 seconds has been reached.
- Test equipment must acknowledge this expiratory time with a double beep.

(page e78, column 3, paragraph 2)
Changes in acceptability 2005 to 2019

6. FIVC in the assessment of FVC

<table>
<thead>
<tr>
<th>2005 standard</th>
<th>2019 standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow volume loop</td>
<td>Flow volume loop</td>
</tr>
<tr>
<td>1. Included a section on performing a flow-volume loop as a manoeuvre separate from spirometry</td>
<td>1. Mandates that the flow-volume loop is an integral part of spirometry.</td>
</tr>
<tr>
<td></td>
<td>2. “If the volume of the maximal inspiration (i.e., FIVC) after EOFE is greater than FVC, then the patient did not start the manoeuvre from TLC.</td>
</tr>
<tr>
<td></td>
<td>3. FEV₁ and FVC measurements from a manoeuvre with FIVC-FVC &gt; 0.100 L or 5% of FVC, whichever is greater, are not acceptable.”</td>
</tr>
</tbody>
</table>
Flow volume loop vs exhalation only

“inspiration at maximal flow back to maximum lung volume”

(page e76, column 3, paragraph 3)
FIVC in the assessment of the FVC
Poll question acceptability

Which one of the options below is not part of acceptability criteria:

a. Satisfactory start of test
b. No early termination
c. Highest FVC is $\geq 150$mls from the next highest FVC
d. There is a 1 second plateau at the end of the test
2. Usability
Usability

Definition

- The criteria applied to blows that have not met acceptability criteria to see if they can still be used for interpretation.
- When every effort has been made to achieve 3 acceptable blows, but acceptability criteria has not been met the operator may assess the trial for usability.

How to do it

- FVC and FEV$_1$ are assessed separately for usability.
- In some instances, the FVC may be used for interpretation but not the FEV$_1$ and vice versa.
Usability

<table>
<thead>
<tr>
<th>2005</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>A usable curve must meet these 2 criteria:</td>
<td>1. Separate FVC and FEV&lt;sub&gt;1&lt;/sub&gt;</td>
</tr>
<tr>
<td>1. Satisfactory start of expiration - EV &gt;5% of FVC or 0.150 L, whichever is greater</td>
<td>2. Check them individually</td>
</tr>
<tr>
<td>2. No cough during the first second of the manoeuvre</td>
<td></td>
</tr>
<tr>
<td>Usability criteria</td>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Must have BEV ≤ 100mls or 5% of FVC, whichever is greater</td>
<td>Yes</td>
</tr>
<tr>
<td>Must have no evidence of a faulty zero-flow setting</td>
<td>Yes</td>
</tr>
<tr>
<td>Must have no cough in the first second of expiration</td>
<td>Yes</td>
</tr>
<tr>
<td>Must have no glottic closure in the first second of expiration</td>
<td>Yes</td>
</tr>
<tr>
<td>Must have no glottic closure after 1 s of expiration</td>
<td>No</td>
</tr>
<tr>
<td>Must achieve one of these three EOFE indicators:</td>
<td></td>
</tr>
<tr>
<td>1. Expiratory plateau (≤0.025 L in the last 1 s of expiration)</td>
<td>No</td>
</tr>
<tr>
<td>2. Expiratory time ≥15 s</td>
<td></td>
</tr>
<tr>
<td>3. FVC is within the repeatability tolerance of or is greater than the largest prior observed FVC</td>
<td></td>
</tr>
<tr>
<td>* or FVC’s must end at exactly the same time</td>
<td></td>
</tr>
<tr>
<td>Must have no evidence of obstructed mouthpiece</td>
<td>No</td>
</tr>
<tr>
<td>Must have no evidence of a leak</td>
<td>No</td>
</tr>
</tbody>
</table>
Poll question usability

Which one of the options below is not part of acceptability criteria:

a. Satisfactory start of test
b. No early termination
c. Highest FVC is $\geq 150\text{mls}$ from the next highest FVC
d. There is a 1 second plateau at the end of the test
3. Repeatability
Repeatability

Definition

• How alike the tests are one to the other. Repeatability indicates that the worker has used the same effort and technique on each blow.

• The repeatability criteria are used to determine when more manoeuvres are needed.

How to do it

1. Acceptability criteria has been checked and met
2. There are a minimum of three blows
3. There are 3 superimposed curves
4. Largest FVC is within 150 ml of the next highest FVC
5. Largest FEV₁ is within 150 ml of the next largest FEV₁
Repeatability

2005 standard

1. Repeatability is achieved when the difference between the largest and the next largest FVC is ≤ 0.150 L and the difference between the largest and next largest FEV₁ is ≤ 0.150 L

2. For those with an FVC of ≤1.0 L, both these values are 0.100 L.

2019 Standard

1. Age >6 yr: The difference between the two largest FVC values must be ≤ 0.150 L, and the difference between the two largest FEV₁ values must be ≤ 0.150 L

2. Age <6 yr: The difference between the two largest FVC values must be ≤0.100 L or 10% of the highest value, whichever is greater, and the difference between the two largest FEV₁ values must be ≤0.100 L or 10% of the highest value, whichever is greater
Figure 11: Example repeatable test result

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pred</th>
<th>LLN</th>
<th>Best</th>
<th>Trial 6</th>
<th>Trial 3</th>
<th>Trial 5</th>
<th>%Pred</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC [L]</td>
<td>4,00</td>
<td>3,11</td>
<td>4,38</td>
<td>4,38</td>
<td>4,32</td>
<td>4,25</td>
<td>109</td>
<td>0,70</td>
</tr>
<tr>
<td>FEV1 [L]</td>
<td>3,16</td>
<td>2,44</td>
<td>2,66</td>
<td>2,63</td>
<td>2,66</td>
<td>2,61</td>
<td>84</td>
<td>-1,14</td>
</tr>
<tr>
<td>FEV1/FVC [%]</td>
<td>79,5</td>
<td>68,3</td>
<td>60,8*</td>
<td>60,1*</td>
<td>61,6*</td>
<td>61,3*</td>
<td>76</td>
<td>-2,74</td>
</tr>
<tr>
<td>FEF25-75 [L/s]</td>
<td>2,89</td>
<td>1,59</td>
<td>1,33*</td>
<td>1,33*</td>
<td>1,39*</td>
<td>1,35*</td>
<td>46</td>
<td>-1,97</td>
</tr>
<tr>
<td>PEF [L/s]</td>
<td>-</td>
<td>-</td>
<td>6,98</td>
<td>6,80</td>
<td>6,98</td>
<td>6,69</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Poll question repeatability

Repeatability criteria for tests in which the FVC’s and FEV1’s ≥ 1L are:

a. ≤ 200mls difference between the highest FVC and second highest FVC as well as the highest FEV₁ and the second highest FEV₁

b. ≤ 250mls difference between the highest FVC and second highest FVC as well as the highest FEV₁ and the second highest FEV₁

c. ≤ 100mls difference between the highest FVC and second highest FVC as well as the highest FEV₁ and the second highest FEV₁

d. ≤ 150mls difference between the highest FVC and second highest FVC as well as the highest FEV₁ and the second highest FEV₁
4. Test quality grading
Test quality grading

**Definition**

The test quality grading system informs the interpreter about the level of confidence that the spirometry results represent the best that the worker was able to do at the time of the test and the probability that an equivalent value would be achieved if the test were to be repeated. Some workers may not be able to meet the criteria for acceptability and repeatability that are necessary for grade A, but nevertheless, their results may be clinically useful.

**How to do it**

Assess the acceptability and then repeatability of the test results and apply a quality grade using the table given.
Test quality grading

2005 standard

- Not referred to specifically

2019 Standard

- The grading system ... expanded to include young children
- ... added to denote “usable” values.
- FEV₁ and FVC are graded separately.
- The grading applies to the set of prebronchodilator manoeuvres as a whole rather than individual manoeuvres and is determined separately for the set of postbronchodilator manoeuvres.
<table>
<thead>
<tr>
<th>Grade</th>
<th>No. of measurements</th>
<th>FVC or FEV$_1$ ≥6 years</th>
<th>FVC or FEV$_1$ &lt;6 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>≥ 3 acceptable</td>
<td>≤ 0.150 L</td>
<td>≤ 0.100 L</td>
</tr>
<tr>
<td>B</td>
<td>2 acceptable</td>
<td>≤ 0.150 L</td>
<td>≤ 0.100 L</td>
</tr>
<tr>
<td>C</td>
<td>≥ 2 acceptable</td>
<td>≤ 0.200 L</td>
<td>≤ 0.150 L</td>
</tr>
<tr>
<td>D</td>
<td>≥ 2 acceptable</td>
<td>≤ 0.250 L</td>
<td>≤ 0.200 L</td>
</tr>
<tr>
<td>E</td>
<td>≥ 2 acceptable</td>
<td>&gt; 0.250 L</td>
<td>&gt; 0.200 L</td>
</tr>
<tr>
<td></td>
<td>OR 1 acceptable</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>U</td>
<td>0 acceptable and ≥ 1 usable</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>F</td>
<td>0 acceptable and 0 usable</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Parameter</td>
<td>Pred</td>
<td>LLN</td>
<td>Trial 2</td>
</tr>
<tr>
<td>-----------------</td>
<td>------</td>
<td>-----</td>
<td>---------</td>
</tr>
<tr>
<td>FVC [L]</td>
<td>3.69</td>
<td>2.92</td>
<td>2.27*</td>
</tr>
<tr>
<td>FEVI [L]</td>
<td>3.13</td>
<td>2.43</td>
<td>1.91*</td>
</tr>
<tr>
<td>FEVI/FVC [%]</td>
<td>84.9</td>
<td>74.1</td>
<td>84.3</td>
</tr>
<tr>
<td>PEF [L/s]</td>
<td>-</td>
<td>-</td>
<td>8.15</td>
</tr>
<tr>
<td>FEF25-75 [L/s]</td>
<td>3.44</td>
<td>1.95</td>
<td>2.26</td>
</tr>
<tr>
<td>BEV [L]</td>
<td>-</td>
<td>-</td>
<td>0.07</td>
</tr>
<tr>
<td>PEFT [s]</td>
<td>-</td>
<td>-</td>
<td>0.06</td>
</tr>
<tr>
<td>FET [s]</td>
<td>-</td>
<td>-</td>
<td>6.9</td>
</tr>
</tbody>
</table>

* Indicates value outside normal range or significant post change.

Session Quality: Pre A (FEVI Var=0.03L (1.3%); FVC Var=0.04L (1.7%))
Poll question quality grading

Test quality grade refers to:

a. Bronchospasm with forced exhalation during spirometry testing
b. The confidence we can have in the quality of the test data
c. The level of impairment when interpreting the test result
d. Whether the test had to be stopped or not
Summary

• The 2019 spirometry guidance is a welcome update to the previous 2005 ATS/ERS Spirometry Standards.

• Many deficiencies in the prior Standards have been corrected and the new standards are more pertinent to the current level of technology.

• It will probably take a while before the existing software is updated to reflect the new standards and in some cases this may never occur.

• Overall: a distinct step forward in spirometry
Questions?