

Childhood Asthma

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Case Study

A two-year-old child presents to your office with a cough, which has been present for three weeks. It is worse at nighttime and with activity. You suspect asthma.

Questions

1. How do I diagnose asthma in childhood?
2. What is the current management of asthma?
3. What are the roles of leukotriene receptor antagonists and long-acting beta-2 agonists?



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The pathophysiology of asthma is an interplay between inflammation, structural airway changes and airway responsiveness. Airway inflammation is characterized by the presence of lymphocytes, eosinophils and mast cells. This airway inflammation has been associated with an increase in airway responsiveness to various stimuli and pathologic airway changes, including airway edema, airway smooth muscle hypertrophy and

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mucous gland hypertrophy.¹ Long-term control has been associated with decreased airway reactivity, partial or complete regeneration of airway pathology and, of course, improved clinical outcome.

This article will deal with the office management of asthma and not the emergency management of an acute attack.

How Do I Diagnose Asthma In Childhood?

The diagnosis of asthma in children is challenging, as spirometry in the young child is difficult. This means the diagnosis will have

to be a clinical one. A good history and physical examination, therefore, are key factors in the diagnosis (Table 1). Often, the diagnosis may not be made at the first visit, but only after recurrent symptoms are found to be present.

The Canadian Asthma Consensus Report states that establishing the diagnosis of asthma in the young patient depends on the following (Table 2):²

- Episodes of wheezing;
- Wheezing after one year of age;
- More than three episodes of wheezing in a year;
- A family history of asthma or atopy;
- A personal history of asthma or atopy;

Summary

Diagnosis and Management of Childhood Asthma

- Long-term control has been associated with decreased airway reactivity, partial or complete regeneration of airway pathology and, of course, improved clinical outcome.
- The diagnosis of asthma in children is challenging, as spirometry in the young child is difficult. This means the diagnosis will have to be a clinical one. A good history and physical examination, therefore, are key factors in the diagnosis.
- Once a diagnosis of asthma is established, it is important to evaluate the severity of illness. This will help you in deciding a treatment regimen.
- The family history, past medical history and environmental history are important in the diagnosis and in establishing a treatment plan.
- Common medications used for treating asthma include short-acting beta-2 agonists, long-acting beta-2 agonists, inhaled glucocorticoids, leukotriene receptor antagonists, and a combination of inhaled glucocorticoids and long-acting beta-2 agonists.
- The management of asthma begins with environmental control and education.
- A written asthma action plan is essential in the treatment plan, ensuring the family knows what to do in the case of an exacerbation.
- To ensure regular follow-up and education, there are many asthma education centers to which families can be referred. There also should be regular review of environmental control, compliance, asthma control, medications and the action plan.

Table 1

The Asthma History

Symptoms

- Cough
- Wheeze
- Shortness of breath
- Chest tightness

Social History

- Level of education
- Social support
- Employment
- Drug plan

Pattern of Symptoms

- Perennial, seasonal or both
- Continual, episodic or both
- Onset, frequency
- Diurnal variation, especially nocturnal and on awakening in early morning

Environmental History

- Age of home
- Heating system
- Wood-burning stove
- Carpet
- Mold/mildew
- Smoking
- Pets
- Environmental history of daycare/school/grandparents

Family History

- Asthma
- Allergies
- Hayfever
- Eczema

Precipitation/Aggravating Factors

- Viral illness
- Environmental allergens (mold, dust mites, animal dander, pollen)
- Exercise
- Environmental change
- Irritants (smoke, air pollutants)
- Emotional (crying, laughing)
- Drugs (acetylsalicylic acid, beta blockers)
- Foods
- Change in weather

Impact of Asthma on Patient

- Emergency room, walk-in clinic visits
- Intensive care unit admissions
- Missed school days
- History of nocturnal waking
- Impact on family routines
- Economic impact

Development and Treatment of Disease

- Age of onset
- Progression of disease
- Present/previous management
- Oral corticosteroids in past

Assessment of Patient's/Parent's Understanding of Illness

- Patient's/parent's knowledge of illness and use of medication
- Perception and beliefs regarding effects of long-term medication
- Level of family support

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Table 2

Indicators For Considering A Diagnosis of Asthma

- Wheezing
- History of any of the following:
 - Cough, particularly night cough
 - Recurrent wheeze
 - Recurrent shortness of breath
 - Recurrent chest tightness
- Symptoms occur or worsen in the presence of:
 - Exercise
 - Viral infection
 - Animal exposure
 - House dust mite exposure
 - Mold
 - Smoke
 - Change in weather
 - Pollen
 - Emotional expression (laughing or crying)
 - Airborne chemicals
- Symptoms occur or worsen at night
- Family history of asthma/atopy

- Maternal smoking;
- Clinical improvement after anti-inflammatory treatment;
- Chronic cough (especially nocturnal or associated with exercise); and
- Wheezing when viral etiology is unlikely.

The likelihood of a diagnosis increases with the number of these factors present.

Once a diagnosis of asthma is established, it is important to evaluate the severity of illness. This will help you in deciding on a treatment regimen. It is best to categorize asthma severity into mild, moderate and severe. This requires careful assessment of symptom frequency and lung function.

The history should include a comprehensive evaluation of symptom frequency during the day and night, as well as during exercise. The pattern of symptom frequency should be established. The symptom history should include cough, chest tightness, shortness of breath and wheezing. The pattern and frequency of beta-2 agonist use should be established. The family history, past medical history and environmental history are important in the diagnosis and in establishing a treatment plan.

The 1997 National Asthma Education and Prevention Program Expert Panel Report 2 helped define asthma severity.³

Mild Asthma. Children who have mild asthma experience daytime symptoms two or fewer times a week and nighttime symptoms twice a month or less. Symptomatic episodes are brief and resolve spontaneously with the use of beta agonists. Between episodes the patients are asymptomatic and, if they are able to do tests, have normal pulmonary functions (forced expiratory flow in one second [FEV1] and peak expiratory flow [PEF] greater than 80% of predicted).

Moderate Asthma. Children whose symptom frequencies exceed those described in the mild category fit into the moderate category. They have nighttime symptoms and may have limitation of daily activity. They are symptomatic between episodes. Their PEF is 60% to 80% of predicted. These patients are likely to have a greater degree of airway inflammation and hyperactivity, and will need to receive daily medication to control their asthma.

Severe Asthma. The child with severe asthma uses beta agonists frequently, has had multiple hospital visits and uses prednisone. They have nighttime symptoms and have limitation of daily activity with school absence. They may have had a prior near fatal episode. The asthma severity categories are summarized in Table 3.²

Table 3

Measures of Asthma Severity

| | Severity of Asthma | | |
|----------------------------------|--------------------|----------------|----------------|
| | Mild | Moderate | Severe |
| FEV1 or PEF % of predicted | > 80% | 60% to 80% | < 60% |
| Need for beta-2 agonist | every 8h | every 4h to 8h | every 2h to 4h |
| Probability of: | | | |
| - Previous near fatal episode | 0 | 0 | + |
| - Recent admission to hospital | 0 | 0 | + |
| - Nighttime symptoms | 0 to + | + | +++ |
| - Limitation of daily activities | 0 to + | + to ++ | +++ |

Table 4

Dose Equivalencies For Inhaled Glucocorticoids

| Product | Dose (µg/day) | | |
|--------------------------------------|---------------|--------------|---------|
| | Low | Medium | High |
| Beclomethasone MDI and spacer | < 500 | 500 to 1,000 | > 1,000 |
| Budesonide turbuhaler | < 400 | 400 to 800 | > 800 |
| Fluticasone MDI and spacer or diskus | < 250 | 250 to 500 | > 500 |
| Beclomethasone MDI (HFA) | < 250 | 250 to 500 | > 500 |

MDI = metered dose inhaler
HFA = hydrofluoralkene propellant

What Are The Medications Used For Asthma?

Before touching upon the management of asthma, the medications used in the current management of asthma will be reviewed.

Beta-2 Agonists. Short-acting beta-2 agonists relax smooth muscles and promote an increase in airflow. They are the first choice for treating acute asthma symptoms and exacerbations. They also

are excellent for preventing exercise-induced symptoms, but should be used on an as-needed basis only. When the use of short-acting inhaled beta-2 agonist exceeds three times a week (in addition to their once-daily use for exercise-induced symptoms), regular anti-inflammatory medications should be added to the treatment regimen.

Long-acting Beta-2 Agonists are beneficial when added to inhaled glucocorticosteroids. They

Table 5

Control Measures of Environmental Factors Contributing to Asthma

Allergens

- Animal dander
 - Removal of the pet from the home is most effective.
 - Exclude pet from the child's bedroom.
 - Seal or cover with a filter air ducts that lead to the child's bedroom.
- House dust mite
 - Maintain relative humidity below 50%.
 - Encase mattress, boxspring and possibly pillows in mite allergen impermeable covers.
 - Launder bed linens in hot water (55° C).
 - Remove carpeting where possible or vacuum weekly.
- Pollen
 - Stay indoor with windows closed during peak season especially in the afternoon.

Tobacco Smoke

- The child's parent should stop smoking or smoke outside.
- If smoking outside, wear a "smoking jacket" that can be removed when coming back in the house, to prevent the child from being exposed to smoke on the parent's clothing.
- Don't smoke in the car.

help with exercise-induced symptoms for longer periods than do shorter acting beta-2 agonists.⁴ Patients receiving moderate doses of inhaled steroids with inadequate symptom control may benefit from adding a long-acting beta-2 agonist rather than increasing the dose of the inhaled

steroid.^{5,6} They should be used as an add-on therapy and are not recommended for relief of acute symptoms or for use in the absence of inhaled anti-inflammatory medications.

Inhaled Glucocorticosteroids are the most effective long-term therapy available. They are well tolerated and safe at recommended doses.⁷ There is a slight decrease in growth velocity with regular use, but attainment of adult height is normal.^{8,9} Childhood asthma itself appears to be associated with delayed maturation and longer periods of reduced growth prior to puberty. These delays, however, do not appear to compromise the attainment of final adult height either.^{10,11}

Inhaled glucocorticosteroids can be divided into low, moderate and high doses (Table 4). The initial dose should be 200 mcg to 1,000 mcg of beclomethasone equivalence. Once results are achieved, the dose should be reduced to the minimum necessary dose. At the first sign of exacerbation, the inhaled steroid should be added or increased two- to fourfold.² This increase should be continued for the duration of the exacerbation and, once control is achieved, the dose should be reduced to the minimum necessary dose. For inhaled steroids, a twice-daily dose is effective, even at high doses. This also ensures compliance. Patients should rinse their mouth after inhalation of steroids to reduce oropharyngeal deposition and possible oral candidiasis. Oral prednisone may be added if the exacerbation is severe.

Leukotriene Receptor Antagonists (LTRAs). Leukotrienes are potent mediators released from mast cells, eosinophils and basophils. They contract airway smooth muscle, increase secretions and attract and activate inflammatory cells.¹² Current recommendations suggest using LTRAs as an alternative to increased doses of inhaled glucocorticosteroids.¹³ They also have been shown to reduce exercise-induced symptoms.¹⁴ There is

Table 6

Indications of Asthma Control

| Parameter | Frequency or Value |
|--------------------------------------|-------------------------|
| Daytime symptoms | < 4 days a week |
| Nighttime symptoms | < 1 night a week |
| Physical activity | Normal |
| Exacerbations | Mild infrequent |
| Absence from school | None |
| Need for short-acting beta-2 agonist | < 4 doses a week† |
| FEV1 or PEF | > 85% of personal best |
| PEF diurnal variation | < 15% diurnal variation |

†May use one dose a day for prevention of exercise-induced symptom
FEV 1= forced expiratory volume in one second; PEF= peak expiratory flow

insufficient evidence to recommend LTRAs as first-line anti-inflammatories in place of inhaled glucocorticosteroids. For patients who cannot or will not use inhaled glucocorticosteroids, however, LTRAs should be the primary treatment of choice.²

Modes of Delivery. There are multiple modes of delivery, which are beyond the scope of this article. In children, if a metered dose inhaler (MDI) is chosen, a spacing device must always be used with the MDI. An MDI with a spacer device is as effective as a nebuliser to deliver medication.¹

Management of Asthma

Environmental Control. The management of asthma begins with environmental control and education. A summary of control measures is presented in Table 5. This is an important part of asthma management and is often overlooked.

Achieve Control. The next step is to rapidly achieve asthma control. If this is a new diagnosis of asthma, begin inhaled glucocorticosteroids. If this is a known asthmatic who is not well controlled (need for beta-2 agonists more than three times a week, or PEF 60% to 80% of predicted), or who is having an exacerbation, inhaled glucocorticosteroids should be started or increased. The starting dosage can be decided on by one of two approaches:

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Table 7

Action Plan

Name: _____

Doctor's Name and Number: _____

Date: _____

GREEN LIGHT

I know my asthma is good if:

- I can breath easy.
- I do not cough or wheeze when I play, exercise or sleep.
- I use my reliever medication, _____, less than four times a week.
- My peak flow is greater than _____ (> 80% of predicted).

My Action Plan is:

- I stay away from my triggers.
- I watch for signs of having asthma trouble.
- I take my medication the correct way.
- _____.
- _____.
- _____.

YELLOW LIGHT

I know I am starting to have trouble if:

- I feel a cold or virus coming on.
- I cough or wheeze when I play exercise or sleep.
- I use my reliever medication, _____, more than four times a week.
- My peak flow is between _____ (60% to 80% of predicted).

My Action Plan is:

- I stay away from my triggers.
- I tell an adult that I am having signs of asthma problems.
- I take my medication the correct way.
- _____.
- _____.
- _____.

Table 7 (cont.)

Action Plan

RED LIGHT

I know my asthma is out of control if:

- I have a lot of trouble breathing when I am sitting, talking or walking.
- My reliever medication is not working or I am needing it more than every four hours.
- My peak flow is less than _____ (< 60% of predicted).

My Action Plan is:

- I ask an adult for help.
- I call 911 or go to the hospital.
- I take my medication the correct way.
- _____.
- _____.
- _____.

1. Start with a high dose until control is achieved (Table 4); or
2. Start with a low dose and gradually step up therapy until control is achieved (Table 4).

There are no studies comparing the two methods. If symptoms are severe, or if PEF is less than 60% of predicted, initial therapy with prednisone should be considered. The use of beta-2 agonists as rescue medication remains important during this phase of treatment.

Maintain Control. The third step is to maintain control of asthma symptoms. Once control is achieved for several weeks or months, reduce the dose of inhaled glucocorticosteroids to the minimum dose required to maintain control (Table 6). If asthma is not adequately controlled by moderate doses (500 µg/day to 1,000 µg/day of beclomethasone or equivalent), additional therapy (long-acting beta-2 agonists or LTRAs) should be considered. Any child who is on regular inhaled glucocorticosteroids, and who is capable, should use a peak flow meter twice a day. Reduction in the peak flow will be an early sign the child's asthma may be getting out of control (Table 6).

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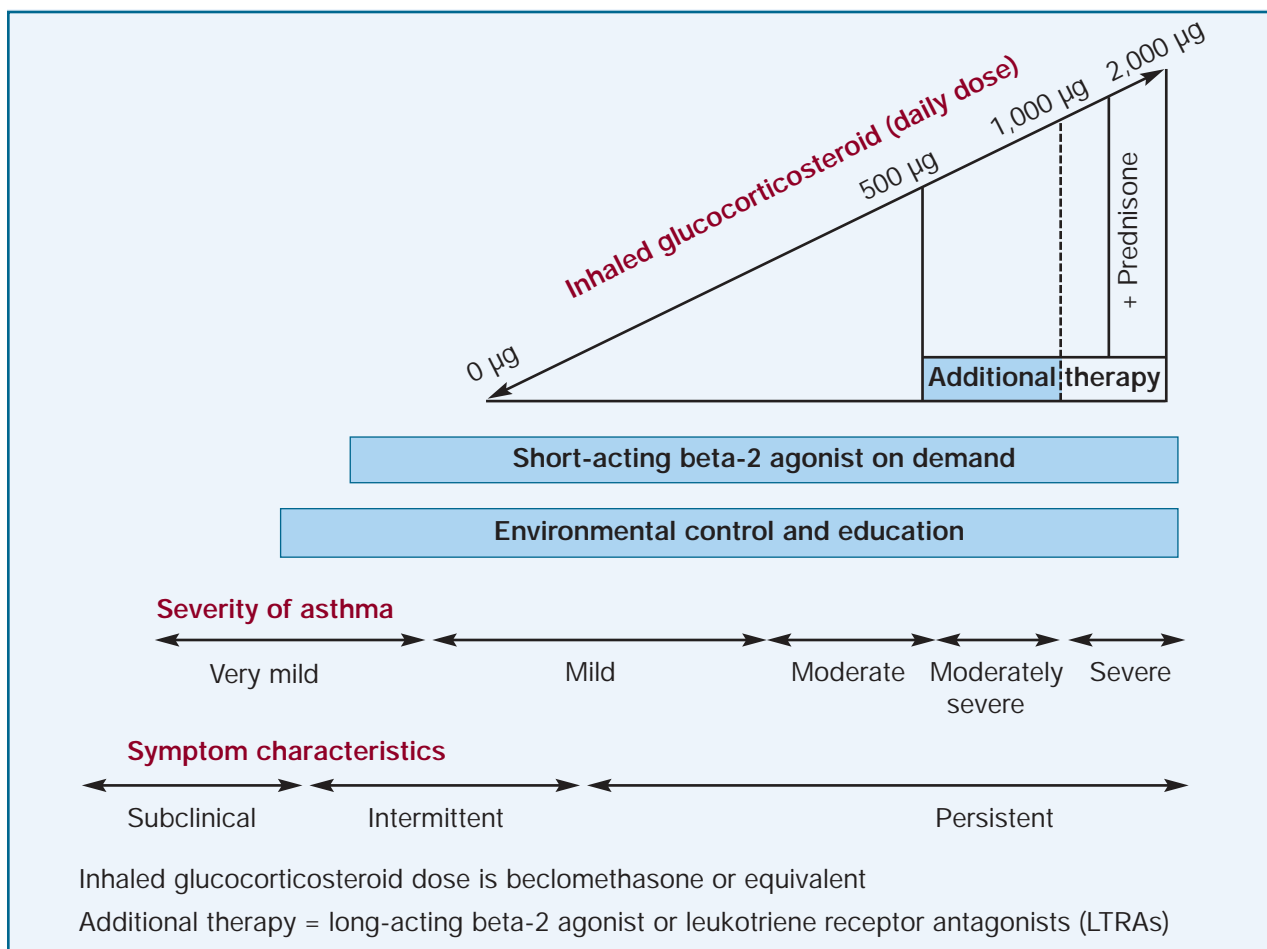


Figure 1. Asthma management overview.

Adapted from: Canadian Asthma Consensus Report. Can Med Assoc J 1999; 161(Suppl. 11):S4.

Earlier in the article, severity was broken down into mild, moderate or severe asthma. When controlled, the mild asthmatic will likely need the occasional dose of beta-2 agonist to increase the frequency of usage during exacerbations, but will not need inhaled glucocorticosteroids. When well controlled, the moderate asthmatic will need beta-2 agonists occasionally and low-to-moderate doses of inhaled glucocorticosteroids with or without additional therapy, depending on the dose of inhaled glucocorticosteroids needed to maintain

control. The severe asthmatic will need beta-2 agonists, a high dose of inhaled glucocorticosteroids and additional therapy.

The Asthma Action Plan. The fourth step is to give the patient or their family a written asthma action plan (Table 7). Ensuring the family has a plan of attack in the case of an exacerbation is an essential part of your treatment plan. If the child is having an exacerbation or their peak flow is between 60% and 80% of predicted, short-acting beta-2 agonists should be used on demand. Inhaled glucocorticos-

teroids should be initiated or increased two- to fourfold. If symptoms are severe, or if peak flow is under 60% of predicted, initial therapy with oral prednisone should be considered in addition to the above measures. Figure 1 summarizes these guidelines.

Ensure Regular Follow-up and Education. The final step is to ensure the family is educated about asthma. There are many asthma education centers families can be referred to. There also should be a regular review of environmental control, compliance, asthma control, medications and the action plan.

Case Discussion

A two-year-old child presents to your office with a cough which has been present for three weeks. It is worse at nighttime and with activity. You suspect asthma. The questions you ask yourself are:

- How do I diagnose asthma in childhood?
- What is the current management of asthma?
- What are the roles of leukotriene receptor antagonists and long-acting beta-2 agonists?

On further history, you discover he has prolonged cough following upper respiratory infections (URIs). A walk-in clinic physician has previously told the child he has wheezes. He has never been told he has asthma, but has twice been told he had “bronchitis,” and was put on antibiotics both times. He has never been treated with inhalers. He has a history of eczema and his mother has asthma. She smokes and there are two cats in the house. His grandfather babysits. There are cats and a wood-burning stove at the grandfather’s home.

You diagnose this child with asthma. You give the family advice on environmental clean-up at home and at the grandfather’s home. You educate the family about asthma and offer a referral to an asthma nurse educator. The child is started on an inhaled short-acting beta-2 agonist MDI, with spacer on a demand basis. You teach the family proper use of the spacer. The child is started on an inhaled glucocorticosteroid at moderate doses *via* MDI and spacer (fluticasone 125 µg, two puffs twice daily). You review the side effects and safety of the medication to ensure compliance, and explain that they should rinse out the child’s mouth after using the inhaled steroid to prevent oral candidiasis. Finally, you arrange follow-up in four weeks.

Four weeks later, the family states the child is 100% better. He no longer has his cough, sleeps through the night without any symptoms and runs around without coughing. He rarely uses his beta-2 agonist. The parents have cleaned up their environment a fair amount, but still smoke in the car. You are very pleased. You now advise the family to wean his inhaled

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steroids to one puff twice daily (250 µg/day of fluticasone). The family does this and the child continues to do well. When they tried to wean the child's medication further, however, his symptoms returned. You decide to keep him at one puff twice daily of fluticasone. This, you remember, is a low-to-moderate dose of inhaled glucocorticosteroid. You again educate the family about the safety of the medication and the proper use of the spacer device, and re-educate them about smoking in the car.

The child is now well controlled on low-to-moderate doses of inhaled glucocorticosteroids. The family knows to use the short-acting beta-2 agonists on demand. You give them a written asthma action plan. If the child begins to have symptoms of asthma, or at the first sign of a viral illness, you advise them to use their short-acting beta-2 agonist on demand every four hours.

You advise the family to increase the dose of the fluticasone two- to fourfold for at least two weeks until the symptoms have resolved, and then to wean the dose back to the maintenance dose. The family is comfortable with the plan. You book regular follow-up and advise them to return to you if the asthma gets out of control. You note that, if in the future the child needs higher doses of inhaled glucocorticosteroids to maintain control, you would consider other therapy with either long-acting beta-2 agonists or LTRAs.

Finally, you also note that when the child is able, you will prescribe him a peak flow meter for him to use at home. CME

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