DIAGNOSIS AND CHRONIC MANAGEMENT OF ASTHMA IN CHILDREN

Developed by Usman Ahmed and Dr. Melanie Lewis for PedsCases.com.
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Introduction:

Hello everyone! My name is Usman, and I am a fourth-year medical student at the University of Alberta. This podcast was developed with the support of Dr. Melanie Lewis, a pediatrician at the Stollery Children's Hospital. Today, we will be talking about the diagnosis of asthma and its chronic management in children.

At the end of this podcast, the learner should be able to:

1. Define asthma and describe its clinical presentation
2. Discuss the criteria for diagnosis of asthma in preschoolers and in children 6 years and above
3. Demonstrate an approach to the initial management of asthma in children
4. Delineate an approach to ongoing management of asthma in children

This podcast will not be discussing the acute management for an asthma exacerbation as this was explained in a previous PedsNote titled 'Acute Asthma Exacerbations' which can be found on the PedsCases website.

Definition:

Let's begin by defining asthma. Asthma is an inflammatory disorder of the airways with episodic or persistent symptoms including wheezing, chest tightness, shortness of breath, or coughing. These symptoms are associated with reversible airflow obstruction due to airway hyperreactivity to endogenous and exogenous stimuli such as exercise, smoke, or cold weather.

Asthma is an important diagnosis to make because appropriate treatment can reduce the risk of permanent airway remodeling and lower lung functioning. The national prevalence of asthma in Canada is 10.8% with over three and a half million individuals over the age of 1 being impacted.

To further elucidate the clinical presentation and diagnosis of asthma, let's work through a case!

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Case Study:

You are a third-year medical student, on your family medicine rotation, who has the pleasure of seeing Ezio, an eight-year-old boy, brought in for a persistent whistling sound heard on expiration by his mother. On first appearance, Ezio appears alert and active in the room and is in good spirits. You do notice some dryness on his cheeks.

Upon taking a detailed history you learn that Ezio has been relatively healthy except for this episodic wheeze that gets worse in the winter or with physical activity. It began when Ezio was 6 years old but has slowly been getting worse to the point where Ezio is unable to keep up with his classmates during activities. Ezio can sleep through the night without any issues. Ezio does not take any medications currently and has no allergies that the family is aware of, although he does seem to have a runny nose in the springtime. He is not in frequent contact with any animals, other than his pet goldfish. Ezio's older sister has eczema but otherwise there is no family history of eczema, asthma, or hay fever.

On further history with regards to his respiratory symptoms, you learn that Ezio has at least 10 days per month where he is having trouble with breathing easy, and it has impacted his ability to keep up with classmates in school. The wheeze can be heard during any time of year, not just when he is sick with the viruses, although it does seem worse in winter months and is exacerbated when he has a cold. He has not required any hospitalizations or emergency room visits in the past. The family has suspected this might be asthma for a while, but never formally had it diagnosed and have not tried any asthma medications.

After taking the history, you proceed to your physical exam. On first appearance, Ezio appears to be in no acute distress. He coughs from time to time. After having him sit on the examining table, with his shirt removed, you observe his breathing pattern. He is mildly tachypneic with a respiratory rate of 30. His oxygen saturations are 96%. The rest of his vitals are normal. There are some signs that he is working a little harder to breathe as his intercostal muscles are indrawing slightly, although there is no tracheal tug, nasal flaring, or head bobbing. On auscultation, you hear a very characteristic expiratory wheeze diffusely throughout the lobes of the lungs bilaterally. His cardiac exam is normal. His abdomen is soft and non-tender, and he has appropriate muscular tone and reflexes. You notice his cheeks as well as the flexor regions of his elbows have dry scaly skin. He also seems to have some crusting around his nares.

At this point, what would you be clinically suspicious of and how would you make the diagnosis in an 8-year-old?

Diagnostic Criteria:

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Based on our detailed history and physical, and with the definition of asthma in mind, you might consider asthma as a possible diagnosis. In children 6 years old and above, the criteria for the diagnosis of asthma includes:

A clinical history and physical exam that is suggestive of asthma. This would include intermittent or chronic asthma-like symptoms as discussed earlier, as well as pertinent findings on exam such as an expiratory wheeze, which is the most common and specific finding in asthma. The diagnosis also requires evidence of reversible airflow obstruction, as determined by pulmonary function testing and exclusion of any alternative diagnosis.

Now, how would our diagnostic criteria change if Ezio was 3 years old instead of 8?

The criteria would be similar; however, it is difficult to complete pulmonary function tests in children less than 5 years of age and therefore this would not be required. A great podcast on the diagnosis and management of asthma in preschoolers can be found on the PedsCases website, but in brief, children aged 1-5 years old with frequent asthma like symptoms are diagnosed based on:

The presence of possible airflow obstruction, as characterized by recurrent (two or more) episodes of wheezing, difficulty breathing and coughing. Additionally, documentation of reversible airflow obstruction that improved with a trial of asthma therapy and exclusion of any alternative diagnosis is also necessary.

It is important to encourage documentation of observed signs and symptoms of airflow obstruction and subsequent improvement with therapeutic trials in the community by parents or guardians, as well as in clinic by health care professionals, as this strengthens the evidence surrounding individuals' diagnosis of asthma. It also allows for more effective monitoring of symptoms over time.

Nonetheless, according to the criteria mentioned for children 6 years old and above, Ezio's clinical presentation is in keeping with an asthma diagnosis, although we still need to exclude alternative diagnoses and perform a pulmonary function test before we can confirm an asthma diagnosis and discuss treatment options.

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Differential Diagnosis:

A differential for persistent or intermittent asthma-like symptoms including wheeze, shortness of breath and cough could include infectious, congenital, or mechanical causes. Infectious etiologies would include recurrent upper respiratory tract infections, chronic rhinosinusitis, croup, pneumonia, or bronchiolitis. Chronic infections such as tuberculosis should also be considered in children who have travelled or been in contact with someone who has tuberculosis. It is important to note that infectious causes would not improve with asthma therapy and symptoms would not be present in the absence of infection, unlike asthma symptoms which are defined as chronic or persistent. Congenital issues might include tracheomalacia, tracheal stenosis, bronchopulmonary dysplasia, or cystic fibrosis, although Ezio has not had his symptoms since infancy. Finally, mechanical causes such as foreign body aspiration should be considered although Ezio's features have not been acute in their onset. GERD should also be considered as this may present clinically as intermittent cough.

In other words, features that would support a diagnosis of asthma include a recurrent wheeze, as well as other asthma-like symptoms that worsen at night (such as cough), are present with or without viral illness, and improve with use of asthma medications. A personal or family history of atopy, which includes asthma, eczema, and hay fever, can also increase clinical suspicion for asthma, but is not required for diagnosis.

In contrast, features that would go against a diagnosis of asthma, include a productive cough, symptoms since birth or symptoms that do not respond to asthma therapy.

That was a lot of information so let's quickly recap the diagnosis of asthma in children.

1) Documentation is **KEY** and parents and healthcare professionals should document observed symptoms and signs of airflow obstruction in the community or in the clinic when possible. It is also critical to document the response to a short acting beta 2 receptor agonist, such as Ventolin and any trials of inhaled corticosteroids or oral steroids such as prednisone or dexamethasone.
2) Consider a history and physical that has features suggestive of asthma, but keep a broad differential which includes infectious, congenital, gastro-intestinal, and mechanical etiologies.
3) Reversible airflow obstruction with asthma therapy can be diagnosed by observed clinical improvement by healthcare professionals or parents of children 1-5 years old, while in children over the age of 5, pulmonary function testing is the standard used to diagnose reversible airflow obstruction.

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Spirometry:

The final step in diagnosing asthma in children 6 years old and above would be completing a pulmonary function test to assess for reversible airflow obstruction. Spirometry is the preferred pulmonary function test and can be completed in most children 5 years old and above. During spirometry, the patient will have two very important values measured – their forced vital capacity or FVC and their forced expiratory volume in 1 second or FEV1. FVC is the total amount of air an individual can expire as compared to FEV1 which is the amount of air expired in 1 second. Airflow obstruction is objectively defined by an FEV1 of less than 80% and an FEV1/FVC ratio of less than 0.85. If airflow obstruction is noted, the vital piece of information regarding an asthma diagnosis, is that it is a reversible obstruction. A short acting beta agonist or SABA should be used and if there is an improvement of 12% or more in the FEV1, the airflow obstruction is considered reversible.

Reversibility is best diagnosed with a SABA response during an acute exacerbation by a health care professional; however, it can also be diagnosed by parental report of improved symptoms with a three-month trial on asthma medications. Improvement with use of a SABA can occur within 20 minutes if there is mild airflow obstruction, however sometimes it may take 2-3 repeated doses in a 60-minute period for moderate to severe airflow obstruction. In addition, suboptimal SABA response may be due to long standing poorly controlled asthma.

It is important to note that a negative spirometry test does not rule out asthma as the individual could have controlled symptoms on the day of the investigation and therefore it is best to perform the spirometry when the asthma is active. If the exam is normal, there is the option to complete a methacholine or exercise stress test to possibly induce airway hyperresponsiveness leading to airflow obstruction. It is important to do these tests in a facility that can care for a child in acute distress and bronchoprovocation testing should not be completed in patients with severe airflow limitation.

As recommended by Choosing Wisely, spirometry, if suggestive of asthma, should be repeated after 4 to 6 weeks of initial asthma therapy to assess for improved airway function. If symptoms remain under control, spirometry should be done every 1 to 2 years.

With all pertinent parts of the diagnostic criteria explained, let's get back to our case!

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Ezio completed the spirometry and had an FEV1 of 68% with an FEV1/FVC of 0.75. After using Ventolin, a common short acting beta agonist medication, Ezio had an FEV1 of 85% - that is an improvement of 17%! These scores indicate reversible airflow obstruction and we have already ruled out alternative diagnosis based on history and physical. You notify Ezio and his mother about the results, your clinical assessment, and the diagnosis of asthma. It is now time to consider what the initial management will look like as the family is motivated to get Ezio's asthma symptoms under control.

Initial Management:

Regardless of a child's age, initial management should begin with educating both the child as well as the parent or guardian. Asthma education includes a discussion surrounding the diagnosis of asthma, its symptoms, treatment, and long-term consequences if left untreated. There should also be a discussion with regards to the elimination of modifiable risk factors or triggers of asthma symptoms. For example, tobacco smoking exposure should be eliminated, and children should receive the annual influenza vaccine. Asthma education also involves discussing the various medications that may be necessary and the importance of adherence to them as well as optimal inhaler technique. A great way to involve the family, as well as the child in their care is by creating a written action plan which describes when to use their medication, what to do if symptoms worsen and when to seek medical help. An example of a written action plan can be found in the **Appendix.**

Regarding medical management, there are three therapeutic categories for patients with asthma. The first category includes controller medications, which are steroid-based, and reduce airway inflammation, control symptoms, and reduce future asthma exacerbation risk. They are typically prescribed to be taken daily and some common examples include inhaled corticosteroids (ICS) such as budesonide and beclomethasone or, an inhaled corticosteroid paired with a long-acting beta agonist (LABA) such as budesonide-formoterol also known as Symbicort, or Advair which is a combination of fluticasone and salmeterol.

The second category of medications are known as reliever or rescue medications, and they are used, as needed, to 'rescue' a patient from worsening asthma or an exacerbation of symptoms. This is typically a short acting beta 2 agonist or SABA, and salbutamol also known as Ventolin is a well-known example.

Finally, the third category of medication is any add on therapy for more severe asthma which is required when symptoms persist despite optimizing high doses of the controller medication as well as ensuring appropriate adherence, technique, and elimination of modifiable risk factors. This category may include treatments such as leukotriene receptor antagonists (montelukast) or biologics.

With respect to medication delivery, it is recommended that children 1-3 years old use a spacer and face mask, while children 4 years and above use a spacer with a mouthpiece. Always recommend the use of a metered dose inhaler as this increases the amount of medication going into the lungs and decreases its side effects. Above the age of 6, children may continue with a metered dose inhaler with a spacer or use a dry powder inhaler if they have adequate inspiratory forces.

In terms of initiating medication regimens, generally, it will be based on the child's presenting frequency and severity of asthma symptoms. The treatment will also be based on the child's age group. The 2020 Global Initiative for Asthma report details three age groups in pediatrics which are 1-5 years, 6-11 years, and 12 years and above.

The following recommendations are based off the 2020 Global Initiative for Asthma report, with preferred treatment organized in a stepwise approach based on presenting symptoms. The 2021 Canadian Thoracic Society's Asthma Management Continuum was also referenced to ensure comparable approaches.

In children 1-5 years old, consider (**Step 1)** an as needed SABA, when they have infrequent viral wheezing episodes. Each subsequent step-up will include a controller therapy in addition to the rescue SABA which does not change. Therefore, to be concise, we will only mention the changes that occur going forward. In children 1-5 years old, consider **(Step 2)** adding a daily low dose inhaled corticosteroid as a controller therapy, when rescue medication is used 8 or more times per month. Consider **(Step 3)** doubling the controller medication dose when asthma symptoms are still not controlled. If the child continues to have uncontrolled asthma symptoms at this point, referral to an asthma specialist is indicated **(Step 4)**.

Moving onto children 6-11 years old, there are a couple of changes to the recommendations. Firstly, there is an option to use an inhaled corticosteroid with a long-acting beta agonist as a controller therapy. In addition, this age bracket has different definitions of presenting symptoms per step in the approach. Unchanged is the recommendation for a short acting beta agonist as the preferred rescue medication, and this does not change between steps.

Therefore, in children 6-11 years old, consider (**Step 1)** an as needed SABA, when symptoms occur a maximum of 2 days per month. Consider (**Step 2)** adding a daily low dose inhaled corticosteroid, when symptoms occur more than 2 days per month. If symptoms occur most days and 1 night per week, consider using a daily low dose ICS-LABA such as Symbicort (**Step 3)**. If symptoms are occurring most days and nights, consider a medium dose ICS-LABA **(Step 4)**. If the child continues to have uncontrolled asthma symptoms at this point, referral to an asthma specialist is indicated **(Step 5)**.

In children 12 and above, the only difference as compared to children aged 6-11 years old is that the recommendation for rescue medication is a low dose inhaled corticosteroid with a long-acting beta agonist, specifically, an inhaled corticosteroid with formoterol such as Symbicort, rather than a SABA. Otherwise, each step's presenting symptoms and preferred management is the same.

Importantly, the 2021 Canadian Thoracic Association report recommends use of inhaled corticosteroid-formoterol formulations as a rescue medication, in children 12 years and above, only when used as monotherapy or when the controller therapy is also an inhaled corticosteroid-formoterol formulation. For example, if a 13-year-old was prescribed a daily low dose inhaled corticosteroid, they should not have Symbicort as a rescue medication. In that case, an as needed short acting beta agonist would be recommended. Additionally, the Canadian Thoracic Association suggests starting a low dose of Symbicort in children 12 years and above when their symptoms are poorly controlled on an inhaled corticosteroid with as needed SABA, or it is well controlled on as needed SABA, but they are at high risk of exacerbations.

Reassessment at follow up appointments will allow for optimization of medication to find the minimum effective dose and regimen required to control asthma symptoms.

In our case study, Ezio is an 8-year-old boy with more than 10 symptomatic days per month and no night symptoms. Based on the 2020 Global Initiative for Asthma algorithm, we would start with a therapeutic trial of low dose inhaled corticosteroid with an as needed SABA inhaler. We would also ensure that we educate both Ezio and his family on the diagnosis, the treatment, and long-term impacts of asthma. We would also assess for modifiable risk factors and ensure they are managed appropriately. We would create a written action plan alongside Ezio and his mother and plan to follow up in 2-3 months with a repeat spirometry test and clinic appointment, while recommending that the family keeps a diary of Ezio's asthma symptoms in the interim.

Ongoing Management:

Once asthma treatment is initiated, ongoing treatment decisions are based on a cycle of assessment, adjustment, and subsequent review of their response. These assessments should be carried out initially every 2-3 months and then may become less frequent based on the severity of continued asthma symptoms. If an exacerbation or hospitalization were to occur secondary to asthma, follow up should occur within 2-4 weeks of the event. Importantly, for children under the age of 6, there is a high rate of symptom resolution and therefore it would be prudent to assess these children at least every 6 months to assess whether they still require daily controller therapy to manage symptoms. A trial of cessation during the season where the child is most symptomatic may be done and should be monitored to assess whether ongoing asthma treatment is required or not.

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In general, at a follow up visit, the assessment will include discussions surrounding two important topics - asthma symptom control and ongoing potential risk factors for future asthma exacerbations.

Asthma is well controlled when daytime symptoms occur a maximum of 2 days per week and a rescue inhaler is required a maximum of 2 times per week. Severe exacerbations are defined as worsening asthma symptoms leading to requirement for an emergency department visit, systemic steroids, or hospitalization for management of asthma symptoms. Mild exacerbations occur when an individual has increased symptoms but does not require any of the above interventions. When we assess the risk of future exacerbations, we look at the child's previous history of severe exacerbations, if they currently have poor asthma control, and if there is an overuse of their rescue inhaler, defined as needing more than 2 rescue inhaler prescriptions filled per year. The assessment of future risk of exacerbations in addition to the patient's current asthma control, influences ongoing medication adjustments.

It is also important to re-assess the patient's comorbidities and ensure medication adherence and appropriate inhaler technique. After a thorough assessment has been completed, adjustments may be made with regards to any modifiable risk factors and educating the family on appropriate inhaler technique and adherence to medications before considering adjustments to the controller medication in a stepwise approach.

If after 2-3 months of therapy, the patient has reported an improvement in asthma symptoms with appropriate control while exposed to triggers such as the cold or during exercise, then a step-down approach may be used to find the patients minimum effective treatment. The 2020 Global Initiative for Asthma report recommends stepping down the inhaled corticosteroid doses by 25-50% at 3-month intervals as long as the symptoms are controlled.

On the other hand, if symptoms persist and/or the patient is having exacerbations, a step-up approach to controller medication dosage may be necessary. However, before ever increasing medications, it is important to assess inhaler technique, adherence, and rule out modifiable risk factors or comorbidities that could be causing this. Afterwards, step up treatment may be considered, as discussed previously. Any change to medication should be regarded as a therapeutic trial and therefore the response should be reviewed after 2-3 months. Make sure to always review the patient's goals at your follow up visits and work together towards patient satisfaction with control of their asthma.

Recall that an asthma specialist referral may be required if the patient continues to have trouble while on a moderate dose of an inhaled corticosteroid with 2 or more exacerbations and/or more than 8 days per month of uncontrolled symptoms. Referral

may also be indicated if the patient has had an ICU admission due to an asthma exacerbation or if there is continued diagnostic uncertainty.

Let's now have a look at how Ezio's asthma was managed over time!

Ezio ended up being managed on a daily low dose inhaled corticosteroid with an as needed short acting beta agonist use for 2 years. Ezio never had any severe exacerbations or hospitalizations due to asthma during this time. By the age of 11, Ezio's symptoms seemed to improve during the winter and during activity and so a step-down approach was initiated at 3-month intervals to reduce the controller therapy dosage. By the time he was 12, Ezio did not require any ongoing asthma treatment other than an as needed rescue medication.

Take Home Points:

That brings us to the end of this podcast! We have reviewed the diagnosis and chronic management of asthma in children and so let's recap with some take home points.

1) Asthma is an important diagnosis to make in children to initiate treatment in order to limit airway remodeling at an early age.

2) The diagnostic criterion for children varies based on whether the child is above or below the age of 6 years old. The major difference being the ability to complete pulmonary function testing in children above the age of 6. Spirometry is the preferred method which may indicate reversible airflow obstruction if there is more than a 12% improvement in the FEV1 after use of a short acting beta agonist.

3) Documentation of asthma like symptoms in the community and clinic, in addition to improvements on asthma therapy, assist in the diagnosis of asthma as well as helping guide future asthma management.

4) It is important to consider a differential diagnosis for persistent wheeze, shortness of breath and cough when assessing for asthma. A differential may include various infectious, congenital, gastrointestinal and mechanical causes.

5) Initial management for asthma includes asthma education, a written action plan, eliminating modifiable risk factors and initiating a therapeutic trial of medication based on presenting symptom frequency and severity. The three medication

categories include controller therapies, reliever therapies and add-ons for persistent, uncontrolled asthma.

6) Follow up should occur every 2-3 months initially and can be subsequently tailored based on the patients' response. Always ensure to reassess asthma symptom control, risk of exacerbation, and confirm inhaler adherence, technique, and elimination of modifiable risk factors before ever suggesting a change to medication dosage or type. Any change in medication is considered a therapeutic trial and should have a follow up assessment in 2-3 months.

This concludes our podcast. Thank you for listening! As a reminder the full transcript for this podcast is available through PedsCases.com

Appendix 1.

References:

ABIM Foundation. "Spirometry for Asthma: Choosing Wisely." *Choosing Wisely | Promoting Conversations between Providers and Patients* (2019). Available from: https://www.choosingwisely.org/patient-resources/spirometry-for-asthma/

Asthma Canada. "Asthma Action Plan." (2021). Available from https://asthma.ca/get-help/living-with-asthma/asthma-action-plan/

Ducharme, Francine M., et al. "Diagnosis and management of asthma in preschoolers: A Canadian Thoracic Society and Canadian Paediatric Society position paper." *Paediatrics & child health* 20.7 (2015): 353-361.

Global Initiative for Asthma. "Global Strategy for Asthma Management and Prevention." (2020). Available from www.ginasthma.org

Lougheed, M Diane et al. "Canadian Thoracic Society 2012 guideline update: diagnosis and management of asthma in preschoolers, children and adults." *Canadian respiratory journal* vol. 19,2 (2012): 127-64. doi:10.1155/2012/635624

Sawicki, Gregory et al. Asthma in children younger than 12 years: Initial evaluation and diagnosis (2021). UpToDate. Available from: https://www.uptodate.com/contents/asthma-in-children-younger-than-12-years-initial-evaluation-and-diagnosis?search=asthma%20children&source=search_result&selectedTitle=3~150&usage_type=default&display_rank=3

Sawicki, Gregory et al. Asthma in children younger than 12 years: Management of persistent asthma with controller therapies (2021). UpToDate. Available from: https://www.uptodate.com/contents/asthma-in-children-younger-than-12-years-management-of-persistent-asthma-with-controller-therapies?search=asthma%20children&source=search_result&selectedTitle=4~150&usage_type=default&display_rank=4

Yang, Connie L., et al. "Canadian Thoracic Society 2021 Guideline update: Diagnosis and management of asthma in preschoolers, children and adults." *Canadian Journal of Respiratory, Critical Care, and Sleep Medicine* (2021): 1-14.