

Course Name: Pulmonary Function Test -Interpretation and Application in clinical practice

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W2_L3_Lung Disorders in Children

Welcome you all to the session on Lung Disorders and Children. I am Dr. Sunita, Assistant Professor in the Department of Pediatrics, Chettinad Hospital and Research Institute. So, the objectives of our today's session will be. So how do we classify our lung disorders, how do we diagnose asthma investigations and treatment for the same. So, this is how we broadly classify the lung disorders as - upper airway obstruction, lower airway obstruction, lung parenchymal disease and disordered pattern of breathing.

How do we say it as an upper airway or a lower airway? It is basically based on the anatomical classification. So, the starting from our nostrils, paranasal sinuses, our pharynx, and the larynx up to the level of focal cord forms the upper airway. Whereas anything below the level of focal cord, the larynx below the level of focal cord, the bronchi, bronchioles, and the lungs per se will form the lower airway. So, any obstruction in the upper airway usually will present with the stridor, the child will present with stridor, noisy breathing and there will be increased work of breathing.

Whereas in a lower airway obstruction it will be the bronchi or the bronchioles which gets obstructed which will lead on to wheezing. A lung parenchymal disease for example, interstitial lung disease or pneumonia, disordered pattern of breathing anything to do with the central nervous system. So, any insult to that will lead on to disordered pattern of breathing. So, in today's sessions we will be exclusively discussing on the lower airway obstruction. In children the most common lower airway obstruction is bronchial asthma.

So how do we define bronchial asthma? It is a heterogeneous disease usually characterized by a chronic airway inflammation. It is also defined as history of respiratory symptoms such as wheezing, shortness of breath, chest tightness which vary over time and intensity which might even increase or decrease with time associated with variable expiratory, variable expiratory airflow limitation. So, what is the incidence? It is as we already discussed it is a chronic respiratory disease which affects starting from 1% to 29% of the population throughout the world in different countries. So, what are asthma phenotypes? It is a heterogeneous disease with different underlying disease processes. It is not a single

phenotype there are multiple phenotypes associated with it that is why it is called as a heterogeneous disease. So, what is a phenotype? It is a recognizable cluster of demographic, clinical and or pathological characteristic which is defined as an asthma phenotype. So, these are all the commonest clinical phenotype of asthma in a child who is more than 5-year-old. So, in a child who is more than 5-year-old and an adolescent child these are even more common cause of phenotypes, common phenotypes of asthma. So first and the foremost is an allergic asthma everyone knows asthma is secondary, could be triggered by an allergen. So, it often commences in childhood associated with the past or a family history need not be a history it could be even a family history of atopic dermatitis or allergic rhinitis or any asthmatic in a first degree relative.

Next coming on to non-allergic asthma which is very less common. Third coming on to adult-onset asthma the child would have been asymptomatic throughout the childhood but it might suddenly start in an adolescent or in the adult period. So, we should also rule out occupational asthma in these kinds of people who get exposed to a lot of allergens during their occupational work. Next coming on to asthma with persistent airflow limitation. So, this long-standing asthma can also cause the airway remodeling. And the last and the final is your asthma with obesity where an obese child will have a prominent respiratory symptom and little eosinophilic airway inflammation.

So, coming on to the symptomatology of your asthma. So, we know the common symptoms of asthma is wheeze and cough, shortness of breath with or without chest tightness. So, basically, there will be more of night symptoms and early morning symptoms. So, they might experience more than one symptom so need not be only cough they can have a cough with wheezing or a cough with increased work of breathing or difficulty in breathing with chest tightness. So, usually, the symptoms would be more in the night and in the early morning rather than during the part of the day and it as we said it varies over time and intensity. It gets usually triggered by a viral infection, exercise, allergen exposure, change in weather, extremes of emotions, laughter, crying and exposure to irritants such as smoke or strong perfume smells also can trigger the symptoms of asthma. So, how is it characterized by? It is usually characterized by airflow obstruction which is reversible and then airway inflammation and airway hyper responsiveness. So, what are all the triggers? So, coming on to the triggers whenever a child comes to us with the history of cough and wheezing, we should also ask for the triggers. So, allergens in the form of any animal dander like exposure to pets like cats or dogs, any dust mite, pollen, or fungi. Other triggers such as your exercise triggered or the child had an upper respiratory tract infection, smoke, extremes of temperature or any strong emotional expression like laughter, extreme laughter or crying, aerosol or chemical exposure and drugs such as NSAIDs and beta blockers. So how do we assess asthma? So, coming on to the assessment of asthma first we assess the asthma control. So how do we assess? So, it is usually done over the last four weeks. So how many episodes of cough or wheezing did the child have for the past four weeks? How

was the risk factor? Was there any risk factor which had exacerbated the asthma? And we measure the lung function test with the trial of inhaled corticosteroid containing treatment which should be done over three to six months and this periodical check should be done at least once a year in for the at-risk patients with severe asthma. Next coming on to addressing the treatment issues.

First you assess the asthma control then we assess the treatment issues. So, what do we assess in treatment issues? We document the patient's current treatment plan, we watch the inhaler technique and we assess the adherence and side effects of the inhaler technique, check the patient has a return asthma plan. Is the treatment protocol clearly given to them? And also ask for their attitudes and goal for asthma and medications. Next coming out assessing the multi morbidity. Is there any other multi morbidity associated with the patient which is triggering this asthma like your rhinosinusitis, rhinitis, gastroesophageal reflux disorder, obesity, obstructive sleep apnea, depression and anxiety which can lead on to poor asthma control.

So now coming on to the scope of PFT. PFT is your pulmonary function test. What is the scope in characterizing your asthma? So, they might have a variable airflow limitation which could be either circadian or episodic in nature. Then the airflow limitation that reverses with bronchodilator administration and an airway hyperresponsiveness which is an excessive decrease in airflow in response to specific stimuli or triggers. So, what do we mean by change in criteria for reversibility? So, when a patient has a baseline airflow limitation, we said there could be a variable airflow limitation. So, bronchodilator responses whenever you give a short acting beta 2 adrenergic agonist, beta 2 agonist. So, the bronchodilator response is defined as an increase in FEV1 or FVC by greater than 10 percent of the mean predicted value. So how do they calculate the bronchodilator response? So, we said there is a there should be bronchodilator responses - increase in FEV1 or FVC. So how do we calculate? So, there is an equation for calculating the *bronchodilator response* is

$$\text{[Postbronchodilator value - Prebronchodilator value]} \times 100 / \text{Predicted value.}$$

The predictive value could be either your FEV1 or your FVC.

So, what is this predicted value? How do we calculate? It is common for age and the height of the child we have certain reference value for the predicted value. So, this has replaced the standard FEV1 or FVC more than 12 % and a baseline of more than 200 ml. What could be the commonest phenotype in a less than 5-year-old child? Again, this is a common chronic disease of childhood. So, what does it lead to? It leads on to school absenteeism, emergency hospital visits and the child being hospitalized 'n' number of times. So, in children who is less than 5-year-old it is usually the first episode is usually a viral induced or a viral-triggered wheeze. So, it is typically associated with an upper

respiratory tract infection which occurs in the age group around 6 to 8 episodes in a year. So, the commonest viral infection associated are is your respiratory syncytial virus and rhinovirus which is associated with recurrent wheeze throughout childhood. So, it is also again a heterogeneous condition and not all wheezing indicates asthma in childhood less than 5-year-old child. A larger proportion of wheezing episode is viral induced whether the child has asthma or not. So, what is a phenotype in a child who is 5 years or less? So, we classify it as symptom-based classification and trend-based classification. So, symptom based we classify it as an episodic wheeze and a multi trigger wheeze. So, episodic wheeze is they have over discrete periods often associated as we said with a viral upper respiratory tract infection and the child will be totally normal in between the episodes of upper respiratory tract infection.

Second comes your multi trigger wheeze where the child even without the upper respiratory infection or any triggers they might have symptoms in between the episodes. Next comes your trend-based classification. Time trend-based classification is based on a retrospective cohort study where they included a transient wheeze and a persistent wheeze. Persistent wheeze is a child who started to have wheeze before the age of 3 and the child is completely normal before the age of 3 years. Persistent wheeze, any symptom be of less than the age of 3 but it persists even after the age of 6 years. So next comes your late onset wheeze. So, any symptom which is happening after the age of 3 years.

So how we probably diagnose asthma? So, there are few symptomatology to diagnose asthma. So, a symptom like cough, sneezing and heavy breathing for more than, sorry for less than 10 days during upper respiratory tract infection which happen 2 to 3 episodes in a year and the child is completely normal in between the episodes. There are no symptoms between the episodes. We classify they might have asthma. Next comes some of them have asthma. So, what are all the symptoms here? So, symptoms like some cough, sneezing and heavy breathing for more than 10 days during an upper respiratory tract infection and more than 3 episodes in a year with worsening symptoms in the night. And in between the episodes the child might have an occasional cough, wheeze, or heavy breathing where we term them as most of them have asthma as a symptom of cough, sneezing, heavy breathing for more than 10 days during an upper respiratory infection with more than 3 episodes in a year with severe episodes and night worsening requiring hospitalization. And even in between the episodes the child has difficulty in breathing, coughing, wheezing and the child has disturbance in the form of not able to play or not able to laugh excessively.

So, these are all the child might turn to asthma even with few they might turn into having asthma and the vice versa might also occur from the most having asthma they can also become fewer having asthma. So, these are all the common symptoms with which the child will present to us in the form of cough, wheezing, difficulty or heavy breathing or shortness of breath, reduced activity they cannot go for an outdoor play, they cannot have

an excessive cry or a laughter with a past or a family history first degree relative having asthma or a family history of atopic dermatitis, allergic rhinitis. Then comes a therapeutic trial with a low dose inhaled corticosteroids or a short acting beta 2 agonist which is given over 2 to 3 months if the child has a response clinical response with less symptoms during the use of therapeutic trial of low dose corticosteroids and if the child again has worsening when we stop these steroids then it is a probable indicator the child is developing features of asthma.

So, what are all the tests to diagnose asthma? So now it is purely a clinical diagnosis all the investigations of very least importance first coming out of chest x-ray as such a chest x-ray does not have much of role. Only it is used to rule out a congenital anomaly in the form of like your tracheomalacia or the child has a congenital lobar emphysema these are all the condition your chest x-ray can rule out. Next coming on to lung function test where a child less than 5 years it is very difficult to make them perform expiratory manoeuvre so it also has a least importance. Next comes your test for allergic sensitization where we do a skin prick test with all the allergens and we check for the specific IgE again these tests only talk about the exposure and the allergic response and does not is not an indicator for asthma. Next comes a **FeNo** which detects the exhaled **Fractional exhaled Nitric oxide** - fractional concentration of exhale nitric oxide and it is just a research tool it is not a confirmatory test to be done.

Next comes a therapeutic trial with the low dose inhale corticosteroid which should be given for 2 to 3 months and we check for the response at the end of 3 months. So, what are all the mimickers of asthma? So, the common mimickers of asthma it can be just a upper respiratory tract infection where after the period of 5 or 10 days a child will be totally asymptomatic with no cough or no shortness of breath in the further episodes. Next coming on to your gastroesophageal reflux, so associated with this a child might also have bouts of vomiting after large quantity of a food, cough and they might also have shortness of breath if they have large quantities of food.

Next coming on to foreign body aspiration it is very common in children when a child comes to you with acute episode of cough or a stridor then we must think of foreign body aspiration. Next is a pertussis where they have protracted episodes of chronic cough. Next is your persistent bronchial bacterial bronchitis where there would have been a fever and a cough and shortness of breath. Next is your tracheomalacia where the child will have cough and shortness of breath or chest deformities since birth, it's a symptom which will start since birth and a congenital heart disease which will also present with cough increased work of breathing. In association the child will also have a cardiac murmur increased liver or a hepatomegaly.

Next coming on to the tuberculosis where there will be fever cough and the fever will not respond to the commonest antibiotics. Next is your bronchopulmonary dysplasia where

the child will have a history of ventilated for a longer period or the child would have required oxygen for a longer period during the newborn period. Next is your immunodeficiency, immunodeficiency child can have recurrent infection it is not only your respiratory infection they can even have a non respiratory infection with failure to thrive. So, these are all the common mimickers of asthma.

So, this is the indication where you will have to do a further diagnostic test or you have to take a therapeutic decision in a child who has failure to thrive or neonatal or very early onset of symptoms, vomiting associated with respiratory symptoms, continuous wheezing, failure to respond to your medications like your low dose inhaled corticosteroids or there is no association of your symptoms with your triggers such as your viral URI or any exposure to allergen or a cardiovascular sign, focal lung or there is a finger clubbing then you have to think in terms of other system involvement and hypoxemia outside the context of viral illness.

So, this is how we plan treatment for a child who is less than 5 years of age. So, it is a stepwise protocol. So, the management is a stepwise protocol. So, the first step whenever you see a child with recurrent episodes of wheezing in between the episodes of URTI also child has started developing episodes of wheeze then we start with the first level of treatment which is inhaled short-acting beta 2 agonist as and when needed. So, what do we mean by as and when needed is whenever the child has symptoms of cough or wheezing or shortness of breath, we use a beta 2 agonist short-acting beta 2 agonist.

Now, when do we step 2? Step 2 jump into step 2. So, whenever there is no control whenever the child starts developing symptoms even with this short acting beta 2 agonist then we move on to the step 2 where we give an initial controller treatment plus as and when required short acting beta 2 agonist. So, what do we mean by this controller treatment? Controller treatment is nothing but our low dose inhaled corticosteroid. So, this we would usually prefer to give over a period of 2 to 3 months; the inhaled corticosteroids will be given over 2 to 3 months. Again, if there is no response with the low dose corticosteroids the next option would be you can prefer a high dose inhaled corticosteroid.

Even if that is not working then we move on to the step 3 protocol where we give additional controller treatment like your leukotriene antagonist plus your short-acting beta 2 agonist and you consider a specialist referral to rule out other therapeutic causes which the child might have. With that also the child is not getting controlled then we move on to the step 4 where we must continue the controller treatment which is your inhaled corticosteroid and we must refer the child for expert assessment. It is not only referring them to a specialist they must do the investigation persistent to the persistent to asthma. So, this is the personalized cycle, asthma care cycle, just by giving medication it is not our work which

is getting resolved. So, we also must check for whether the child is getting controlled with whatever medications we have provided.

So, we must assess for any excluding the alternate diagnosis. So, we saw a list of mimickers of asthma. So, we must exclude the alternate diagnosis with what all we saw and then we must see for the symptom control has a child responded with what the medications what we have given and whether we are able to modify the risk factors is there any comorbidities involved, like in the form of rhinitis, rhinosinusitis or any GERD which is associated or there is a child moving towards obesity. Then you must properly teach them the inhaler technique and you must check for whether they are adherent to the inhaler technique and caregiver preferences and goal you must talk to the caregivers also regarding what we are treating the child with.

Then we must adjust. So, what do we adjust? We must adjust the modifiable risk factors and comorbidities and a non-pharmacological strategies asthma medications, education, and skill training. So, once we see a control then we must come down on the dose of medication. If there is no control then we must increase the dose of medication that is what we mean by adjusting the asthma medication and we must educate and train them on the inhaler technique and we must review. What do we have to review? Occasionally we must call them to look for how is the symptom, is there any exacerbation with the symptom, is there any side effect of the medication, what is the risk factor associated with it, comorbidities anything is been associated is the caregiver satisfied, are the parents satisfied with the treatment with what we are providing. So, this is the personalized asthma care management cycle.

The take home message is in children the most common lower airway obstruction is our bronchial asthma which is a heterogeneous disease with various asthma phenotypes. It is mostly a clinical diagnosis there is no single investigations which will yield you a diagnosis and the treatment protocol is mainly a stepwise approach rather than being a single treatment protocol.