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Study of dynamic lung parameters in bronchial Asthma

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Abstract
Introduction: Bronchial asthma is a chronic disease of airways which affects children as well as adults. Pulmonary function test is an easy and non-invasive technique to diagnose and assess the severity of the disease. Our aim was to assess the severity of the disease by spirometry.
Material and method: Spirometry was done in forty bronchial asthma patients and equal number of healthy individuals of similar age range of 20-60yr. Dynamic lung parameters like FVC, FEV1, FEV1/FVC%, PEFR, MEFR, MMEFR were recorded. Tests were repeated after inhalation of 2 puffs of salbutamol in asthma patients and improvement were recorded. Statistical analysis was done by SPSS 16.
Result: There was marked improvement in the values of all parameters as compared to the control group. After bronchodilator inhalation there was significant improvement in the parameters specially marked in case of FEV1(38.5%), PEFR(40%), MMEFR(25.5%).
Conclusion: Pulmonary function test is a simple non-invasive method to diagnose and assess the improvement during treatment in patients of bronchial asthma.

Keywords: Pulmonary function test, Spirometry, Bronchial asthma, salbutamol

Introduction

The NHLBI defined asthma in 2002 as a chronic inflammatory disorder of the airways in which many cells and cellular elements play a role. The chronic inflammation causes recurrent episodes of wheezing, breathlessness chest tightness and coughing, particularly at night and in the early morning. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment [1].

PREVALENCE-Asthma is one of the most common chronic diseases globally and currently affects approximately 300 million people worldwide. The prevalence of asthma has risen in affluent countries over the last 30 years but now appears to have stabilized with approximately 10-20% of adults and 15% of children affected by the disease. In developing countries where the prevalence of asthma had been much lower, there is a rising prevalence of, which is associated with increased urbanization. The prevalence of atopy and other allergic diseases has also increased at the same time, suggesting that the reasons for the increase are likely to be systemic rather than confined to the lungs. Most patients with asthma in affluent countries are atopic, with allergic sensitization to the house dust mite, other environmental allergens such as animal fur & pollens.

Asthma can present at any age, with a peak age of 3 years. In childhood, more males are affected, but by adulthood sex ratio has equalized.

Several risk factors that predisposes to asthma have been identified like [2]

Endogenous Factors	Environmental Factors
Genetic predisposition	Indoor allergens
Atopy	Outdoor allergens
Airway hyper responsiveness	Occupational sensitizers
Gender	Passive smoking
Ethnicity	Respiratory infections
Obesity	Diet

Pulmonary function test: The diagnosis of asthma is usually apparent from the symptoms of variable and intermittent airways obstruction, but must be confirmed by objective measurements of lung functions.

CIBA Guest Symposium in1959 accepted the following tests as essential in any case of obstructive pulmonary disease [3].

1. Forced vital capacity
2. Forced expiratory volume in first second of expiration
3. FEV1/FVC percentage

Material & Method: The present study was carried out on forty selected individuals of bronchial asthma attending the outpatients department of Medicine, Pulmonary medicine VIMSAR. Forty healthy adults of the same age group and sex distribution volunteered as control in the present study. Patients having recent respiratory tract infection and having any other medical illness were excluded from study. All subjects were informed about the purpose of the study and tests were done after taking their consent. Pulmonary function test was done on all the subjects using computerised spirometer, which is a precalibrated electronic spirometer. Following dynamic lung parameters were recorded i.e. FVC, FEV1, FEV1/FVC%, PEFR, MEFR & MMEFR. After the initial reading (premedication reading), 2 puffs of Salbutamol (40 micrograms) was inhaled by each bronchial asthma patient and the test was repeated.

Precautions- The patients exposed to this study were instructed to discontinue bronchodilator preceeding eight hours of test to make sure that there is no residual bronchodilator effect.

Technique for inhalation from Metered Dose Inhaler: The inhaler is held upright between thumb and forefinger. The mouth piece of the inhaler is brought to about 2-4 cm in front of an open mouth. The person breathes out slowly and completely. The inhaler is activated by pressing down the canister while taking a slow, deep breath in 5-6 seconds. Breath is held at full inspiration for 10 seconds. The person should wait for 1 to 3 minutes before taking next puff. Salbutamol inhaler contains 200 metered doses of salbutamol, each puff releasing 100 micrograms. When the patient follows proper technique nearly 10-20% of the drug (20 microgram) is delivered from the inhaler to the lungs and the remaining part gets deposited in the mouth, pharynx and larynx as observered by Dolovich in 1981 [4].

The post medication values were compared with the premedication values in asthmatics. Statistical analysis was done by statistical software SPSS16. Statistical tests applied were unpaired 't' test and paired't' test. P value <0.05 was considered to be significant.

Observation

Table 1: Comparison between Age, Height, Weight and BSA of study and control group

	Age (years)		Height (cm)		Weight (kg)		BSA (Sq mt)	
	study	control	study	control	study	Control	Study	control
Mean±SD	39.7±12.05	39.07±11.71	162.42±4.83	159.95±6.24	54.7±8.04	54.17±7.7	1.57±0.11	1.54±0.11

The above table shows the comparison between the mean age, mean height and mean body surface area (BSA) of subjects of study and control group. SD-Standard Deviation. Sq mt -square meter

Table 2: Spirometric Values in Male (mean)

Age(yrs)	(20-24)	(25-34)	(35-44)	(45-54)	(55>)
	n=2	n=6	n=3	n=3	n=6
FVC (L)	3.54	3.52	2.79	3.14	2.94
FEV1 (L)	3.07	2.92	2.25	2.59	2.35
FEV1/FVC%	86.99	83.22	80.48	82.55	80.06
PEFR (L//min)	571.6	494	380	482.55	462

The above table shows the spirometric values of control male subjects of present study in different age groups

Table 3: Spirometric Values Female (mean)

Age(yrs)	(20-24)	(25-34)	(35-44)	(45-54)	(55>)
	n=2	n=5	n=6	n=5	n=2
FVC (L)	2.32	2.70	2.36	2.42	1.8
FEV1 (L)	2.12	2.39	2.25	2.03	1.45
FEV1/FVC%	90.86	88	85.05	83.23	81.6
PEFR (L/min)	366	422	398.3	358	340

The above table shows the spirometric values of control female subjects of present study in different age groups.

Table 4: Comparison between mean Respiratory Rate, FVC, FEV1, FEV1/FVC%

	Respiratory Rate (breath/min)		FVC(ml)		FEV1(ml)		FEV1/FVC%	
	Study	Control	Study	Control	Study	Control	Study	Control
	n=40	n=40	n=40	n=40	n=40	n=40	n=40	n=40
Mean	21.95	18.1	2115	2852	1354	2410	66.5	84.7
SD	1.49	0.87	436.03	561.5	333.4	454.3	7.56	4.93
SE	0.27		112.41		89.1		1.42	
't' test	14.25		6.55		11.84		15.14	
P	<0.001		<0.001		<0.001		<0.001	

The above table shows the comparison between the study and control groups. The differences between the two groups are statistically highly significant as p value is less than 0.001.

S.E-Standard Error of the difference between the two means, 't'- Unpaired t test, FVC-Force vital capacity, FEV1=Forced expiratory volume in 1st second,

Table 5: Comparison between PEFR, MEFR and MMEFR

	PEFR(L/min)		MEFR(L/min)		MMEFR(L/min)	
	Study	**control**	**Study**	**control**	**Study**	**control**
MEAN	256.55	440.77	134.84	325.05	108.7	220.32
SD	78.02	70.19	56.9	69.66	53.26	48.07
SE	16.59		14.22		11.34	
't' test	11.1		13.37		9.84	
P	<0.001		<0.001		<0.001	

The above table shows the comparison between premedication study cases & control groups. The difference between the two groups are statistically highly significant as p value is less than 0.001.

S.E-Standard Error of the difference between the two means. 't'-Unpaired t test PEFR=Peak expiratory flow rate, MEFR=Maximum expiratory flow rate, MMEFR=Maximum mid expiratory flow rate.

Table 6: Comparison between Respiratory Rate, FVC, FEV1, FEV1/FVC% of Post medication study cases and Control Group

	Resp rate (breath/min)		FVC(ml/breath)		FEV1(ml/breath)		FEV1/FVC %	
	Study	**control**	**Study**	**control**	**Study**	**control**	**Study**	**control**
Mean	19.25	18.1	2518.5	2852.6	1877.7	2410.5	74.32	84.76
SD	1.36	0.87	500.94	561.56	469.12	454.31	7.83	4.93
SE	0.25		118.98		103.25		1.33	
't' test	4.56		2.8		5.16		7.82	
P	<0.001		<0.01		<0.001		<0.001	

The above table shows the comparison between postmedication study cases and control groups. The difference between the two groups are statistically highly significant as the p value is less than 0.001.

S.E-Standard Error of the difference between the two means, 't'- Unpaired t test, FVC-Force vital capacity, FEV1=Forced expiratory volume in 1st second,

Table 7: Comparison between PEFR, MEFR & MMEFR of post-medication study cases and control subjects

	PEFR(L/min)		MEFR(L/min)		MMEFR(L/min)	
	Study	**control**	**Study**	**control**	**Study**	**control**
Mean	361.3	440.77	164	325	136.44	220.32
SD	111.16	70.19	73.43	69.66	67.23	48.07
SE	20.78		16		13.06	
T test	3.82		10.05		6.41	
P	<0.001		<0.001		<0.001	

The above table shows the comparison between postmedication study cases & control groups. The difference between the two groups are statistically highly significant as p value is less than 0.001.

S.E-Standard Error of the difference between the two means. 't'-Unpaired t test PEFR=Peak expiratory flow rate, MEFR=Maximum expiratory flow rate, MMEFR=Maximum mid expiratory flow rate.

Table 8: Comparison between Respiratory rate, FVC, FEV1 and FEV1/FVC% of Premedication & Postmedication study cases.

	Resp. rate (breath/min)		FVC(ml/breath)		FEV1(ml/breath)		FEV1/FVC%	
	Premed	**Postmed**	**Premed**	**Postmed**	**Premed**	**Postmed**	**Premed**	**Postmed**
MEAN	21.95	19.25	2130.75	2518.5	1354.95	1877.7	63.14	74.32
SD	1.49	1.36	436.03	500.94	333.41	469.12	7.56	7.83
SE	1.13		26.8		33.02		0.74	
't' test	2.64		15.02		15.66		15.08	
P	<0.01		<0.001		<0.001		<0.001	
% change	12%		18%		38.5%		17.7%	

The above table shows the comparison between Premedication and Postmedication study cases. The difference between the two groups are statistically significant as indicated by the p value (< 0.001).

S.E-Standard Error of the difference between the two means, 't'- Paired t test, FVC-Force vital capacity, FEV1=Forced expiratory volume in 1st second

Table 9: Comparison between PEFR,,MEFR & MMEFR of premedication and postmedication study cases

	PEFR(L/min)		MEFR(L/min)		MMEFR(L/min)	
	Premed	**Postmed**	**Premed**	**Postmed**	**Premed**	**Postmed**
MEAN	256.55	361.3	134.84	164.06	108.7	136.44
SD	78.02	111.16	56.9	73.43	53.26	67.23
SE	6.54		4.6		2.47	
't' test	16.01		6.34		11.18	
P	<0.001		<0.001		<0.001	
% change	40.83%		21.67%		21.51%	

The above table shows the comparison between Premedication and Postmedication study cases. The difference between the two groups are statistically significant as indicated by the p value(< 0.001),more so in PEFR as there is 40.83% improvement

S.E-Standard Error of the difference between the two means. 't'-Paired t test PEFR=Peak expiratory flow rate, MEFR=Maximum expiratory flow rate, MMEFR=Maximum mid expiratory flow rate.

Table 10: Normal Expected Spirometric Values (mean±SD) MALE-INDIA

Age (yrs)	(15-19)	(20-24)	(25-34)	(35-44)	(45-54)	(55>)
FVC	3.49	3.65	3.59	3.31	3.14	2.98
SD	0.57	0.53	0.54	0.62	0.65	0.67
FEV1	3.04	3.09	2.9	2.6	2.42	2.35
SD	0.52	0.51	0.47	0.53	0.49	0.51
FEV1/FVC%	87.1	84.6	80.6	78.4	77.4	78.9
SD	11	7	9	10	10	9
PEFR (L/min)	530	553	559	512	471	451
SD	72	72	87	98	91	102

Table 11: Normal Expected Spirometric Values (Mean±Sd) Female – India

Age(yrs)	(15-19)	(20-24)	(25-34)	(35-44)	(45-54)	(55>)
FVC	2.46	2.42	2.31	2.24	1.98	1.40
SD	0.47	0.52	0.42	0.40	0.44	0.28
FEV1	2.08	2.07	1.85	1.85	1.64	1.23
SD	0.42	0.45	0.41	0.34	0.30	0.38
FEV1/FVC %	85.4	86	84.5	82.9	84	87
SD	15	17	12	12	10	23
PEFR(L/min)	400	394	364	360	328	282

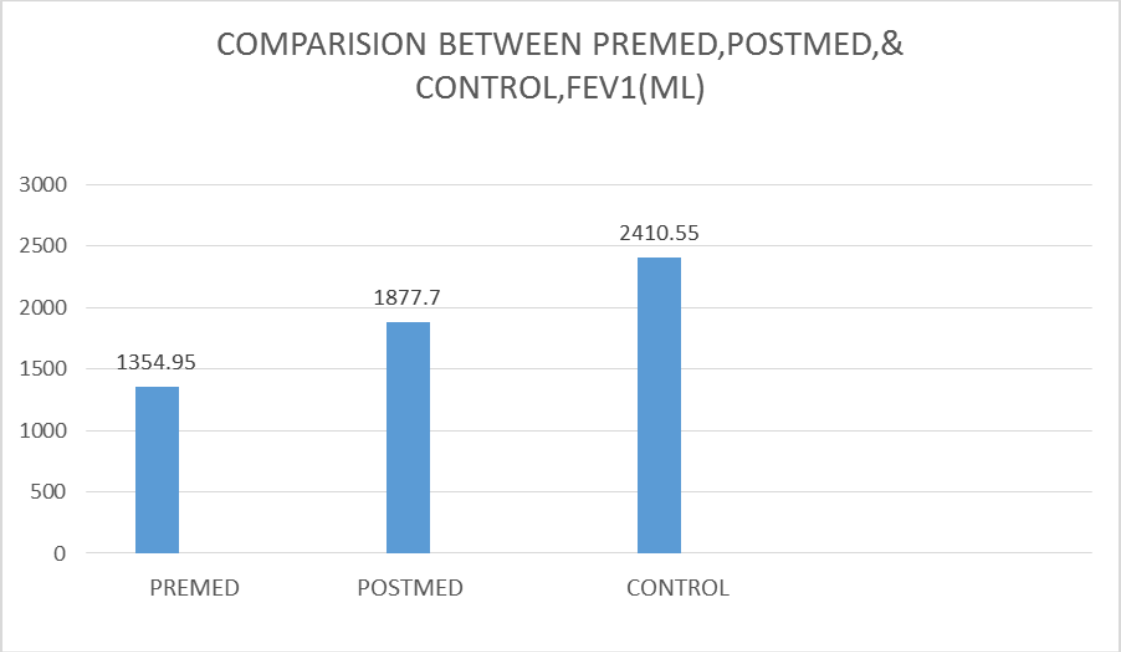
Table 12: Effect Of Salbutamol on FVC, FEV1, FEV1/FVC%, PEFR, MEFR & MMEFR (In different age groups) n=40+40

	Age Group (20-40 YRS)			**Age Group (41-60 YRS)**		
	PRE MED Means ±SD	**POST MED Means ±SD**	**% Increase**	**PRE MED Means ±SD**	**POST MED Means ±SD**	**% Increase**
FVC (ml)	2238.50 ±410.67	2759.20 ±434.23	17	1923 ±361.57	2277.9 ±452.35	18
FEV1 (ml)	1506.42 ±284.46	2136.90 ±364.97	41	1203.5 ±314.61	1618.5 ±420.82	34
FEV1/FVC %	64.28 ±5.90	77.51 ±5.26	20	62 ±8.93	71.13 ±8.77	14
PERF (L/min)	277.41 ±71.29	391.80 ±88.42	41	235.70 ±80.61	330.8 ±124.86	40
MEFR (L/Min)	157.33 ±60.46	194.18 ±78.15	23	112.35 ±43.89	133.95 ±55.25	19
MMEFR (L/Min)	129.8 ±59.58	165.70 ±75.08	27	87.60 ±36.56	107.2 ±42.89	22

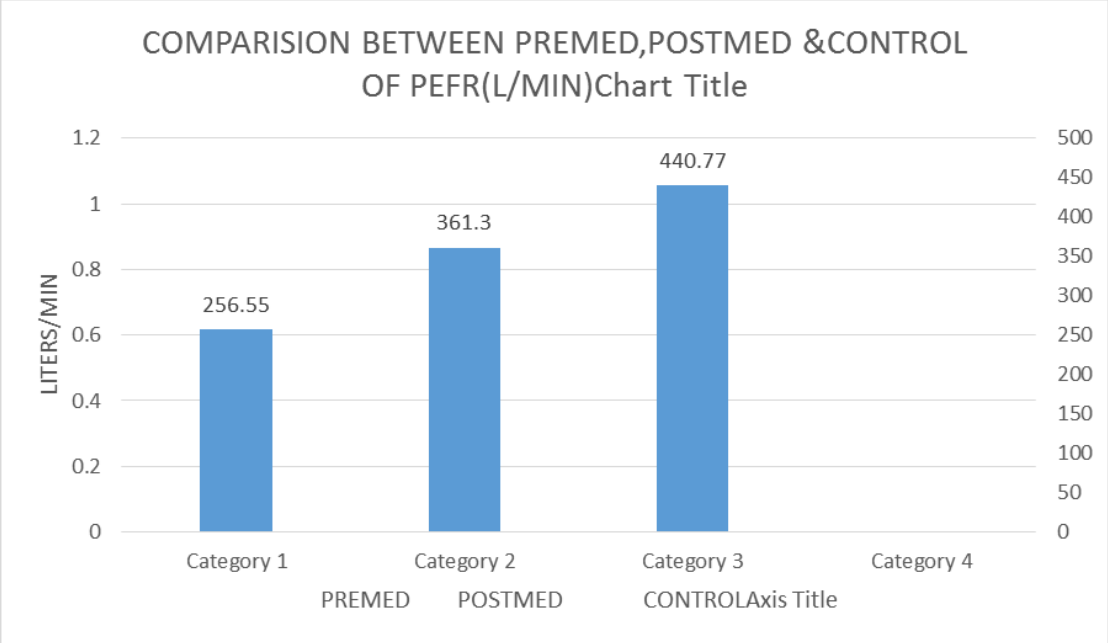
Table 13: Effect of Salbutamol on FVC, FEV1, FEV1/FVC%, PEFR, MEFR & MMEFR (In different sexes) n=40+40

	Male			**Female**		
	PRE MED Means ±SD	**POST MED Means ±SD**	**% Increase**	**PRE MED Means ±SD**	**POST MED Means ±SD**	**% Increase**
FVC (ml)	2273.5 ±480.85	2689.60 ±558.56	18	1988 ±340.78	2347.5 ±376.18	18
FVC1 (ml)	1485 ±332.49	2031.40 ±485	36	1224.90 ±286.40	1724 ±408.39	40
FEV1/FVC %	64.32 ±7.42	75.30 ±6.93	17	61.96 ±7.70	73.35 ±8.71	18
PERF (L/min)	275.10 ±89.48	389.2 ±120.47	41	238 ±61.35	333.40 ±95.98	40
MEFR (L/Min)	152.58 ±63.36	187.23 ±81.31	22	117.10 ±44.37	140.90 ±57.68	20
MMEFR (L/Min)	126.70 ±58.88	159 ±58.88	25	90.70 ±40.92	113.90 ±52.97	25

Comparison between premedication, Post medication & control FEV1(ml) present study



Comparision between Premedication, Post medication & control. PEFR



Discussion

In the present study, age, height, weight and body surface area of the control group are almost similar to the study group in the age group of 20-60 years as evident from observation table no-1

Several workers have tried to standardise the pulmonary function parameters in different age groups in India. When compared to the findings of Pande *et al.* [4] (table-10 & table-11) in the present study it was found that FVC,FEV1in all age groups (table 2 &3) in males is almost similar to their values. The FEV1% was lower in all age groups in males& lower values were found for PEFR.

When the parameters in the present study were compared for female control cases, the FVC values were almost similar in all age groups, but higher values were found for FEV1, FEV1% & PEFR.

In the study group, the values of mean premedication FVC, FEV1, FEV1/FVC%, PEFR, MEFR and MMEFR are lower than the mean control values as shown in observation table no-4 & 5.The decrease was statistically significant. These findings correlated to that of Puri *et al.* (1975) [5], Mahajan *et al.* [6] and Bhalla *et al.* (1979) [7].

They observed a significant decrease in the mean FVC, FEV1 and FEV1/FVC% in cases of Bronchial asthma.

The mean premedication value of PEFR and MMEFR of the study cases are significantly lower as compared to the mean control values suggesting obstruction of large and small airways respectively. These findings are similar to those of Bhalla *et al.* (1979) [7]. Who observed similar low values of PEFR & MMEFR.

The mean premedication value of MEFR is also significantly lower than the mean control values as seen in

observation table no-5, which suggests that there is obstruction of medium sized airways. This finding correlates with those of Bhalla *et al.* (1979) [7] who found significant low values of MEFR in bronchial asthma.

The study cases showed significant lower values in dynamic lung parameters like FVC, FEV1, FEV1/FVC%, PEFR & MMEFR as compared to control subjects. This indicates the presence of airway obstruction. After 10 minutes of administration of 2 puffs of Salbutamol, lung parameters were assessed. The post medication values showed statistically significant increase over the premedication values. This confirmed the diagnosis of asthma as per the criteria fixed by Mc Fadden [8].

FVC: Observation table no-8 shows 18% improvement of mean postmedication FVC as compared to premedication FVC. the finding is similar to Jindal *et al.* (1989) [9] and Guleria *et al.* (1991) [10].

FEV1: Study cases showed a significant improvement of 38.5% of mean FEV1 after bronchodilator inhalation. This finding correlates well with Puri *et al.* (1975) [6], Guleria *et al.* (1991) & Nissar *et al.* [11] who also observed more than 15% improvement after bronchodilator inhalation.

FEV1/FVC%: In the present study an improvement of 17.7% was seen after Salbutamol inhalation, which was similar to the observations of Jindal *et al.* (1989) [9] & Guleria *et al.* (1991) [10].

PEFR: Showed a 40.8% improvement of postmedication values over premedication values. This correlates with the findings of Puri *et al.* (1975) [6], Banerjee *et al.* (1975) [12] & Guleria *et al.* (1991) [10]

MEFR: Table -9 shows significant improvement of MEFR of 21.6% after salbutamol. This correlates with the findings of Puri *et al.* [6] & Guleria *et al.* (1991) [10]

According to Mc Fadden (1981) [8] the diagnosis of asthma is established by observing 25% or greater improvement of at least two parameters after inhalation of a beta agonists in symptomatic asthmatics. In the study subjects there was more than 25% increase in values (FEV1-38.5%, PEFR-40.8%, MMEFR-25.5%). This confirms the Diagnosis of Asthma. But the parameters were not totally reversible as the postmedication values were lower than control values (Table no-6 &7).

Table no-13 gives a comparative study of effect of salbutamol on both the sexes. All the lung parameters showed similar degree of reversibility in both the sexes except FEV1 & FEV1/FVC%. In female subjects they showed higher reversibility. This was explained by the fact that more numbers of mild cases of asthma were included in the female groups. Regarding the reversibility in different age groups, the younger age groups (20-40yrs) showed better reversibility than the older age groups (41-60yrs) as seen in table no-12 in all the three parameters like FEV1, PEFR and MMEFR. This is similar to the findings of Hudon *et al.* (1997). [13] & Jindal *et al.* (1996) [9]. They found that progressive decrease in the number & function of beta receptors is the main cause. Pathak *et al.* & Kenneth *et al.* (1997) [14]. attributed this to replacement of elastic tissue by fibrous tissues and emphysematous change in alveoli in long standing bronchial asthma.

Conclusion

The following conclusions have been derived from the present study that airway hyper responsiveness and edema of the bronchial wall are the principal causes of bronchospasm in bronchial asthma. Bronchodilators when administered in aerosol form, relieves bronchospasm with minimum side effects. Pulmonary function tests reflect the severity and document the reversibility of airway obstruction after bronchodilator therapy. Even though other tests are available these simple non-invasive tests will help the clinicians in diagnosis of asthma by differentiating from other conditions with wheeze.

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