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Cross Sectional Study of Pulmonary Hypertension in Tertiary Car E Center in Assam

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ABSTRACT

Pulmonary hypertension(PH) comprises a group of clinical and pathophysiological entities with similar features but a variety of underlying causes. There are several etiologies for PH. Pulmonary hypertension (PH) can be the result of heart, lung or systemic disorders. From the present study, it can be concluded that Pulmonary Hypertension is a debilitating disease, which needs early detection, complete etiological evaluation and treatment strategisation. The middle aged females are more commonly affected with Pulmonary Hypertension. Breathlessness was the most common symptom at the time of presentation. Most frequent general examination finding was elevated JVP. Majority of the patients had mild hyoxemia in ABG and in spirometry, restrictive pattern was the most common abnormality detected. ECG changes of right heart strain and an elevated NTProBNP level were seen in majority of the cases. The most common parenchymal abnormality in Chest X-ray and CT Thorax were reticular opacities. The ratio of diameters Main Pulmonary Artery and Ascending Aorta was found to be more than 1 in majority of the cases. In this study, most number of cases were found to have Pulmonary Hypertension of moderate severity. Echocardiography of the patients showed dilatation of Right Atrium/ Ventricle and IVC Collapsiility of less than 50% in the majority and these findings were found to be more frequent in the more severe group of Pulmonary Hypertension. Most of the patients had a Tricuspid Regurgitation Jet Velocity of more than 3.4m/s. The most common underlying etiology was left heart diseases followed by lung diseases. Valvular heart disease was the most frequent left heart disease and COPD was the most common chronic disease causing Pulmonary Hypertension. Other causes are found to be less frequently involved. As there are very limited studies done on evaluation of Pulmonary Hypertension in India, more elaborate and larger studies are needed to establish the clinical and etiological profile of Pulmonary Hypertension.

I. INTRODUCTION

The definition of pulmonary hypertension according to the Sixth World symposium on Pulmonary hypertension in 2018 is as a mean pulmonary arterial pressure (mPAP) greater than 20 mm HG at rest and pulmonary vascular resistance greater than 3 wood units. The general purpose of clinical classification of PH is to categorize clinical conditions associated with PH based on similar pathophysiological mechanisms, clinical presentation, haemodynamic characteristics and therapeutic management. Considering these factors, pulmonary hypertension has been divided into 5 groups as follows: 1.pulmonary arterial hypertension2. pulmonary hypertension due to left sided heart disease; 3. pulmonary hypertension due to lung disease or hypoxia; 4.chronic thromboembolic pulmonary hypertension and; 5.pulmonary hypertension with unclear or multifactorial mechanism[1,2]

The Etiological profile and prevalence of Pulmonary Hypertension in various disorders has not been given adequate attention and there is paucity of data from our country on this aspect. Also, early diagnosis and appropriate treatment is associated with improved long term survival and evaluation of these patients is a rational strategy for an improved outcome. A humble attempt was made to conduct this study to determine the etiological profile and evaluation of Pulmonary Hypertension at a Tertiary Care Hospital in North east India, within all the constraints and limitation of one-man study.

This is a hospital based study carried out in the Department of Pulmonary Medicine, Department of Internal Medicine, Department of Cardiology and allied specialties, Gauhati Medical College &Hospital, Guwahati

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SELECTION OF CASES
Patients were included in the study after considering the inclusion and exclusion criteria and written informed consent from the patients were taken

INCLUSION CRITERIA
Patients who meet the following criteria will be included in the study.
1. Subjects of age> 18 years
2. Subjects with PASP ≥ 40mmhg by transthoracic 2 dimensional echocardiography.

EXCLUSION CRITERIA-
1. Suspected cases of pulmonary hypertension who does not meet the echocardiographic criteria
2. Patients not giving consent
3.Patients with active tuberculosis

STUDY DESIGN
It is a hospital based single centered observational study.
STUDY LOCATION
The study was conducted in Gauhati medical college and hospital, Guwahati.
STUDY DURATION
The study was carried out over a period of 1 year from 1st August 2021 to 31st July 2022.

II. RESULTS

A total of 412 patients attending the outpatient and indoor of the Department of Pulmonary medicine, Cardiology, Internal medicine and its allied specialities, who presented with clinical features suggestive of Pulmonary Hypertension were screened using echocardiography. Among them,334 patients did not meet the inclusion criteria. The remaining 78 patients who met the inclusion criteria were included in the study. A detailed clinical history, physical examination and necessary laboratory investigations were done in all the cases
The results and observations of the data were recorded in tabular form. Bar diagrams, histograms and pie diagrams were used wherever necessary. Appropriate statistical methods were applied, calculated and presented.

Table 1 –Sex wise distribution of cases

Sex	sex	Percent
Female(F)	42	53.8
Male(M)	36	46.2
Total	78	100

In the present study, 78 cases were included. Out of 78 cases, majority of the cases (53.8%) were females and 46.2% were males.
The Male to Female ratio was 1.16: 1

Table 2- Age wise distribution of cases

Age	Number of cases	Percent
18-30	7	9
31-40	13	16.7
41-50	18	23.1
51-60	20	25.6
61-70	12	15.4
>70	8	10.3
Total	78	100

In the present study, the age group of patients ranged from 18 years to 85 years with a mean age of 51.0±15.5 years. The highest number of cases 25.6% were seen in the age group of 51 – 60 years. Lowest number of cases 9% were seen in the age group of 18-30 years. The highest age of case recorded in this study was 85 years

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Table 3- Age and sex wise distribution of cases

	Gender			p value
Age group (years)	Male Number (%)	Female Number (%)	Total Number (%)	
18-30	1(2.8%)	6(14.3%)	7(9%)	
31-40	4(11.1%)	9(21.4%)	13(16.7%)	
41-50	9(25%)	9(21.4%)	18(23.1%)	
51-60	8(22.2%)	12(28.6%)	20(25.6%)	0.095
61-70	9(25%)	3(7.1%)	12(15.4%)	
>70	5(13.9%)	3(7.1%)	8(10.3%)	
Total	36(100%)	42(100%)	78(100%)	

In the present study, it was found that majority of female cases (28.6%) were in the age group 51-60 years and males(25%) were in the age group of 41-50 and 61-70 years. The minimum number of cases among the males (2.8%) were in the age group of 18-30 years whereas the minimum number of cases among the females(7.1%) were in the age group of 60-70years and >70 years. The P value was .095 which was found to be significant

Table 4- Mean age group according to sex distribution

	Number of cases	Mean age	Std. Deviation	p value
Male	36	56.33	13.632	<0.001
Female	42	46.43	15.666	
Total	78	51.00	15.487	

From this study it was found that the mean age group among the male patients was 56.33 ± 13.66 years and in females it was 46.43 ± 15.66 years. The mean age of the study population was 51 ± 15.48 years. The P value was <.001 which was found to be significant

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Table 5-distribution of cases according to Body Mass Index(BMI)

BMI(kg/m^2)	Number of cases	Percent
<18.5	14	17.9
18.5-24.9	44	56.4
25.0-29.9	16	20.5
30.0 & Above	4	5.1
Total	78	100

In the present study, the majority of the patients (56.4%) had their BMI in the normal range of 18.5-24.9 kg/m2. Also 20.5% cases were in the pre-obese category (BMI range 25.0-29.9 kg/m2) and 17.9% were in the underweight category (BMI<18.5 kg/m2) while 5.1% patients were found to be in the obese category with BMI>30.0 kg/m2\ Table 5.1: mean Body Mass Index(BMI) of the study population

Table 5.1: mean Body Mass Index(BMI) of the study population

	N	Mean	Median	SD	Minimum	Maximum
BMI	78	22.1	21.0	4.1	16.0	36.0

The mean BMI population of the study population was found to be 22.1± 4.1 kg/m2.

Table 6- Distribution of cases according to smoking status

Smoking history	Number of cases	Percent
Yes	35	44.9
No	43	55.1
Total	78	100

In this study, it was found that out of 78 cases, majority of the cases (55.1%) were non-smokers followed by 44.9% of cases, who were smokers.

Out of the 78 cases studied, 42 cases were females and 17(21.8%) among them had the history of exposure to biomass fuel, whereas the remaining 78.2% cases did not give any such history

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Table 7- Distribution of cases according to biomass exposure

h/o biomass exposure	Number of cases	Percentage
No	61	78.2
Yes	17	21.8
Total	78	100

Out of the 78 cases studied, 42 cases were females and 17(21.8%) among them had the history of exposure to biomass fuel, whereas the remaining 78.2% cases did not give any such history

Table 8- Distribution of cases according to exposure to any drugs

h/o drug intake	Number of cases	Percent
No	76	97.4
Yes	2	2.6
Total	78	100

Out of 78 cases studied, only 2(2.6%) cases gave the history of cocaine intake and the rest 76 cases (97.4%) did not give any such history. Both of them also tested positive for HIV

Table 9- Distribution of cases according to symptoms

symptoms	**Number of cases**	**Percentage (%)**
chest pain	**35**	**44.8**
breathlessness	**77**	**98.71**
cough	**44**	**56.41**
hemoptysis	**10**	**12.82**
palpitation	**49**	**62.82**
syncope	**8**	**10.25**
fever	**6**	**7.69**

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In this study, the most common symptom was breathlessness which was present in 98.71%cases, followed by cough which was observed in 56.41%cases. Chest pain was present in 44.8% of cases. Out of the 78 cases, 12.82% patients presented with hemoptysis while 10.25% patients presented with syncope. Fever was observed in lowest number of cases]

Table 9- Distribution of cases according to symptoms

symptoms	Number of cases	Percentage (%)
chest pain	35	44.8
breathlessness	77	98.71
cough	44	56.41
hemoptysis	10	12.82
palpitation	49	62.82
syncope	8	10.25
fever	6	7.69

In this study, the most common symptom was breathlessness which was present in 98.71%cases, followed by cough which was observed in 56.41%cases. Chest pain was present in 44.8% of cases. Out of the 78 cases, 12.82% patients presented with hemoptysis while 10.25% patients presented with syncope. Fever was observed in lowest number of cases (7.6%).

Table 10- table showing general examination findings in the study population

General Examination	Number of cases	Percent
Clubbing	2	2.6
Elevated JVP	38	48.7
Lymphadenopathy	3	3.8
Pallor	12	15.4
Pedal Edema	9	11.5
Cyanosis	2	2.6
Normal Findings	27	34.6

In this study, it was observed that out of the total 78 cases, elevated JVP was the most common general examination finding which was present in 48.7% of the cases, followed by pallor which was seen in 15.4% of the case population. Pedal edema was seen in 11.5% of the cases and lymphadenopathy in 3.8% of the cases. Clubbing and cyanosis were the least common general

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examination findings and each was found in only 2.6% of the cases. General examination was normal in 34.6% of the cases.

Table 11- Table showing distribution of physical findings suggestive of Pulmonary Hypertension

findings s/o PH	Number of cases	Percent
loud p2	52	66.7
parasternal heave	15	19.2
murmur-(PSM in tricuspid area /ESM in pulmonary area)	13	16.6

In this study, it was found that the most common physical finding suggestive of pulmonary hypertension was loud P2 which was seen in 66.7% of the study population and the least common one was murmur, seen in only 16.6% of the cases. Parasternal heave was seen in 19.2% of the cases.

Table 12- Table showing associated comorbidity among study population

Co Morbidity	Number of cases	Percent
None	15	19.2%
Hypertension	44	56.4%
Type 2 DM	33	42.3%
Hypothyroidism	9	11.5%

In this study it was found that the most common comorbidity was Hypertension (56.4 % cases) and the second most common comorbidity was Type 2 Diabetes Mellitus(42.3%). On the other hand, hypothyroidism was diagnosed in 11.5% and 19.2 % had none of these comorbidities

Table 13- GRADING OF HYPOXEMIA ACCORDING TO ABG

PaO2	Number of cases	Percent
>80 (No Hypoxemia)	16	20.5
60-79 (Mild)	39	50
40-59 (Moderate)	18	23.1
<40 (Severe)	5	6.4
Total	78	100

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Out of 78 patients, 20.5% cases had no hypoxemia according to ABG analysis, whereas majority of cases (50%) had mild hypoxemia on presentation. Moderate hypoxemia was seen in 23.1% cases and there were 6.4% patients in this study group who had severe hypoxemia

Table 13.1- Mean PaO2 in ABG

	N	Mean	Median	SD	Minimum	Maximum
PaO2(ABG)	78	66.7	68.5	14.0	36.0	92.0

The mean PaO2 value of the study population was found to be 66.7±14mmHg.

Table 14- Distribution of cases according to spirometry results

spirometry	Number of cases	Percent
Obstructive	15	19.23
Restrictive	21	26.93
Normal	36	46.15
Could not be done	6	7.69
Total	78	100

In this study, it was found that spirometry was normal in 46.15% of cases. Obstructive pattern was found in 19.23% of cases while 26.93% showed Restrictive pattern. Spirometry could not be done in 7.69% cases. The most common pattern of abnormality among the78 cases was restrictive pattern

Table 15- table showing distribution of ECG changes

	ECG changes of right heart strain Number (%)	ECG changes of left heart strain Number (%)
Absent	37(47.4%)	48(61.5%)
Present	41(52.6%)	30(38.5%)
Total	78(100%)	78(100%)

The current study showed that the signs of right heart strain on ECG was seen in 52.6% of the cases, whereas it was not seen in 47.4% of the cases and the majority of the cases (61.5%) showed no signs of left heart strain and only 38.5% of the cases had ECG changes of left heart strain.

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Table 16 table showing NTProBNP elevation in the study population

NTProBNP elevated	Number of cases	Percent
No	36	46.2
Yes	42	53.8
Total	78	100

In the present study, majority (53.8%) of the patients had an elevated NTProBNP levels while 46.2% of the cases had a normal NTProBNP level.

Table 17-Table showing Chest X ray findings in the study population

CXR finding	Number of cases	Percent
Normal parenchyma	55	70.5
Hyperinflation	6	7.6
Reticular opacities	11	14.1
Nodular opacities	3	3.8
Ring like opacities	3	3.8
Cardiomegaly	35	44.9
Dilated pulmonary artery	25	32.1

Chest Xray was done for all cases and it was found that 70.5% cases had no parenchymal abnormality in Chest Xray. The most common parenchymal abnormality was reticular opacity seen in 14.1% of the cases. Hyperinflation was observed in 7.6% cases whereas Ring like opacities and Nodular opacities were found in only 3.8% cases each. Prominence of pulmonary artery on Chest Xray is a significant finding to suggest presence of Pulmonary Hypertension. It was observed in 32.1% of all cases. Cardiomegaly in Chest Xray was seen in 44.9% cases.

Table 18- Table showing CT thorax findings in the study population

CT thorax finding	Number of cases	Percent
Normal parenchyma	29	37.2
Emphysema	7	9
Bronchiectasis	7	9
GGO	11	14.1
Reticular opacities	25	32.1
Honeycombing	4	5.1
MPAD/AAD>=1	60	76.9

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In this study, CT thorax was done for all cases and normal parenchyma was seen in 37.2% of all cases. Majority of the cases (32.1%) had reticular opacities on CT thorax, though in Chest Xray it was seen only in 14.1% cases. The second most common finding was ground glass opacification which was seen in 14.1%. Also 9% of the study population showed bronchiectasis and emphysema in CT Thorax and honeycombing was seen in 5.1% cases. A major parameter studied was the ratio of diameters of main pulmonary artery and ascending aorta. Ratio of more than or equal to 1 was suggestive of presence of pulmonary hypertension. This ratio was found to be more than or equal to 1 in 76.9% of all cases.

Table 19-Table showing Mean Pulmonary Artery Pressure(mPAP) and PH severity in the study population

Mean PAP (severity of PH)	Number of cases	Percent
20-35(mild)	16	20.5
>35-45(moderate)	37	47.4
>45(severe)	25	32.1
Total	78	100

Echocardiography was done for all patients and out of the 78 patients studied, majority of the patients (47.4%) had moderate PH, 32.1% had severe PH and 20.5% had mild PH.

Table 19.1: table showing mean value of mean pulmonary artery pressure(mPAP) of the study population

	N	Mean	Median	SD	Minimum	Maximum
2D ECHO_mPAP(mmhg)	78	39.8	40.0	7.1	27.0	51.0

The mean mPAP value of the study population was found to be 39.8±7.1mmHg

Table 20- table showing cases with RA/RV dilatation in echocardiography

2D ECHO_RA/RV dilated	Number of cases	Percent
No	33	42.3
Yes	45	57.7
Total	78	100

In the present study it was found that right atrial and right ventricular dilatation was present in 57.7% cases. It was absent in the rest 42.3% cases

Table21-severity wise distribution of patients with RA/RV dilatation in echocardiography

2D ECHO_RA,RV dilated	2D ECHO_PH grade				
	Mild Number(%)	Moderate Number(%)	Severe Number(%)	Total Number(%)	p value
No	14(87.5%)	17(45.9%)	2(8%)	33(42.3%)	<0.001
Yes	2(12.5%)	20(54.1%)	23(92%)	45(57.7%)	
Total	16(100%)	37(100%)	25(100%)	78(100%)	

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In the present study, it was found that the percentage of cases with mild and moderate PH who showed RA/RV dilatation was 12.5% and 54.1% respectively, whereas 92%cases with severe PH showed RA/RV dilatation.

Table 22- Table showing Inferior Vena Cava (IVC) Collapsibility-

2D ECHO IVC collapsibility<50%	Number of cases	Percent
No	25	32.1
Yes	53	67.9
Total	78	100

Among the 78 cases of PH, 67.9% showed an IVC collapsibility of <50% and the rest 32.1% had an IVC collapsibility of >50%.

Table 23-severity wise distribution of patients with Inferior Vena Cava (IVC) Collapsibility<50%

2D ECHO_IVC collapsibility <50%	2D ECHO_PH grade				
	Mild Number(%)	Moderate Number(%)	Severe Number(%)	Total Number(%)	p value
No	14(87.5)	11(29.7)	0(0)	25(32.1)	
Yes	2(12.5)	26(70.3)	25(100)	53(67.9)	
Total	16(100)	37(100)	25(100)	78(100)	<0.001

In the present study, it was found that the percentage of cases in mild and moderate PH who had IVC collapsibility less than 50% was 12.5% and 70.3% respectively whereas all of the cases (100%) with severe PH showed an IVC collapsibility of less than 50%,which was found to be statistically significant (p value <.001)

Tricuspid regurgitation jet velocity was recorded by echocardiography for all patients. Out of all cases, we found that majority of patients (51.3%) had tricuspid regurgitation jet velocity more than 3.4 m/s. In 42.3 % of all cases, the velocity was between 2.8 to 3.4 m/s and 6.4 % of all cases had tricuspid regurgitation jet velocity less than 2.8m

Table 25- Distribution of cases according to WHO 2013, NICE classification.

Group of PH	Number of cases	Percent
Group I	18	23
Group II	32	41
Group III	17	21.7
Group IV	4	5.1
Group V	7	9
Total	78	100

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Out of the 18 patients with Group I PH, the most common etiology was idiopathic PH (33.3%) Connective tissue disease was found in 27.7% of patients and congenital heart disease in 22.2%. HIV infection and portopulmonary hypertension were the etiology in 11.1% and 5.55% of patients respectively.

Table 26.2-Etiology distribution of Group II PH

Group II	Number of cases	Percentage
left heart failure with reduced ejection fraction	11	35.5%
left heart failure with preserved ejection fraction	7	22.6%
Valvular Heart Disease	14	41.9%

In our study, in PH patients due to left heart diseases, valvular heart disease was found to be the commonest cause (41.9%) followed by left heart failure with reduced ejection (35.5%) and left heart failure with preserved ejection (22.6%)

Table 26.3-Etiology distribution of Group III PH

Group III	Number of cases	Percentage
Bronchiectasis	2	11.7%
COPD	7	41.2%
ILD	5	29.5%
OSA	3	17.6%

In our study, COPD was found to be the most common lung cause of PH (41.2%), followed by ILD (29.5%) and OSA (17.6%). Bronchiectasis was seen in 11.7% cases of Group III PH.

Table 26.4-Etiology distribution of Group IV PH

Group IV	Number of cases	Percentage
CTEPH	2	50%
pulmonary embolism	2	50%

In this study, CTEPH and pulmonary embolism were the etiologies identified in Group IV PH. Half of the patients had CTEPH while the other half had pulmonary embolism

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Table 26.5-Etiology distribution of Group V PH

Group V	Number of cases	Percentage
CKD(Chronic Kidney Disease)	4	57.1%
Sarcoidosis	2	28.6%
Sickle cell disease	1	14.3%

In the present study, 57.1% of Group V PH had CKD, while 28.6% had sarcoidosis and 14.3% had sickle cell disease as the underlying etiology.

III. DISCUSSION

A total of seventy-eight cases who fulfilled the inclusion criteria were included in the study.

SEX

In the present study, majority of the cases (53.8%) were females and 46.2% were males. The Male to Female ratio was 1:1.16. **Claudia Tueller et al**.(3,) conducted a study in 1999 in 250 patients of PH and found a female preponderance with 59% of the patients being females and 41% males..This might.Thus there must be a genetic or hormonal predisposition

AGE

In the present study, the age group of patients ranged from 18 years to 85 years with a mean age of 51.0±15.5 years. The highest number of cases 25.6% were seen in the age group of 51 – 60 years. Lowest number of cases 9% were seen in the age group of 18-30 years. The highest age of case recorded in this study was 85 years and the lowest age was 18 years(4) In a study carried out by **Marc Humbert et al**. in 674 patients in the year 2006, the mean age of the study population was found to be 50±15 years; ranging from 18–85 year and also the highest number of cases were found to be in the age group of 51-60 years.(4)

BODY MASS INDEX(BMI)

In the present study, the majority of the patients (56.4%) had their BMI in the normal range of 18.5-24.9 kg/m2. Also 20.5% cases were in the pre-obese category (BMI range 25.0-29.9 kg/m2) and 17.9% were in the underweight category (BMI<18.5 kg/m2), while 5.1% patients were found to be in the obese category with BMI>30.0 kg/Similar observations were made in the study conducted by **S. Harikrishnan et al.** in 2018, where the mean BMI of the cases was found to be 23.2±4.4 kg/m2. (5)

EXPOSURE HISTORY

In this study, it was found that out of 78 cases, majority of the cases (55.1%) were non-smokers followed by 44.9% of cases, who were smokers. (6) The study carried out by **Marius M.Hoeper et al.**153 in 2007 in PAH cases showed that 44% of the cases were smokers

CLINICAL EXAMINATION

SYMPTOMS In this study, the most common symptom was breathlessness which was present in 98.71% of cases. The second most common symptom was cough which was seen in 56.41%.**Stuart Rich et al**.64 (1987) studied the clinical features in patients with PH and concluded that Dyspnea was the most common symptom and was present in 98% of patients at the time of diagnosis

SIGNS

In this study, it was observed that out of the total 78 cases, elevated JVP was the most common general examination finding which was present in 48.7% of the cases, followed by pallor which was seen in 15.4% of the case population. Pedal edema was seen in 11.5% of the cases and lymphadenopathy in 3.8% of the cases. Clubbing and cyanosis were the least common general examination findings and each was found in only 2.6% of the cases. General examination was normal in 34.6% of the cases.

In this study, it was also found that the most common physical finding suggestive of Pulmonary Hypertension was loud P2 which was seen in 66.7% of the study population and the least common one was murmur, seen in only 16.6% of the cases. Parasternal heave was seen in 19.2% of the cases(6). In the study conducted by **Kiran K.**

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Khush et al.(2009) in patients with heart failure, an elevated JVP was found in 76.25% of the PH patients. [7]

ARTERIAL BLOOD GAS ANALYSIS(ABG)

Out of 78 patients, 20.5% cases had no hypoxemia according to ABG analysis, whereas majority of cases (50%) had mild hypoxemia on presentation. Moderate hypoxemia was seen in 23.1% cases and there were 6.4% patients in this study group who had severe hypoxemia.

The mean PaO2 value of the study population was found to be 66.7±14mmHg.

M.M. Hoeper et al. (2007) studied Blood gas abnormalities in patients with idiopathic pulmonary arterial hypertension (IPAH) and found that the mean PaO2 among the IPAH cases was 69±14mmHg. in 7.69% cases. The most common pattern of abnormality among the78 cases was restrictive pattern. [7]

ECG CHANGES

The current study showed that the signs of right heart strain on ECG was seen in 52.6% of the cases, whereas it was not seen in 47.4% of the cases. Also, the majority of the cases (61.5%) showed no signs of left heart strain and only 38.5% of the cases had ECG changes of left heart strain In the study conducted by **Stuart Rich et al**. (1987) in patients with PH, the electrocardiogram showed right ventricular strain in 74% of the cases. [5]

NTProBNP level

In the present study, majority (53.8%) of the patients had an elevated NTProBNP levels while 46.2% of the cases had a normal NTProBNP level.

In the study carried out by **Hanno H.Leuchte et al.**165 (2007) in 118 patients with PH 66 (55.9%)cases had elevated NT-proBNP levels of at least 2.5 times above normal. 9)

CHEST X-RAY

Chest Xray was done for all cases and it was found that 70.5% of all cases had no parenchymal abnormality in Chest Xray. The most common parenchymal abnormality was reticular opacity seen in 14.1% of the cases. Hyperinflation was observed in 7.6% cases whereas Ring like opacities and Nodular opacities were found in only 3.8% cases each. Prominence of pulmonary artery on Chest Xray is a significant finding to suggest presence of Pulmonary Hypertension. It was observed in 32.1% of all cases. [10] In the study conducted by **Stuart Rich et al**.64 (1987) in patients with PH, the electrocardiogram showed right ventricular strain in 74% of the cases[6]

CT THORAX

In this study, CT thorax was done for all cases and normal parenchyma was seen in 37.2% of all cases. Majority of the cases (32.1%) had reticular opacities on CT thorax, though in Chest Xray it was seen only in 14.1% cases. The second most common finding was ground glass opacification which was seen in 14.1%. Also 9% of the study population showed bronchiectasis and emphysema in CT Thorax and honeycombing was seen in 5.1% cases. A major parameter studied was the ratio of diameters of main pulmonary artery and ascending aorta. Ratio more than or equal to 1 was suggestive of presence of pulmonary hypertension. This ratio was found to be more than or equal to 1 in 76.9% of all cases. [11] Ground glass opacification was the most common CT finding(41%) in the study conducted by **S Rajaram et al**.n 292 patients of PAH.

RA/RV DILATATION

It was found that right atrial or right ventricular dilatation was present in 57.7% of all cases. It was absent in rest 42.3% of the cases. right atrial or right ventricular dilatation was present in 57.7% of all cases. It was absent in rest 42.3% of the cases.

Here, it was also found that the percentage of cases in mild and moderate PH who showed RA/RV dilatation was 12.5% and54.1% respectively, whereas 92%cases with severe PH showed RA/RV dilatationIn the study conducted by **Eduardo Bossone et al.**180 (1999) in 51 patients of primary pulmonary hypertension, it was found that 92% of cases had enlarged right atrium and 98% had enlarged right ventricle[12]

IVC COLLAPSIBILITY

Among the 78 cases of PH, 67.9% showed an IVC collapsibility of <50% and the rest 32.1% had an IVC collapsibility of >50%.In the study conducted by **Stefano Ghio et al.**181 (2010) in 59 IPAH cases, IVC collapsibility was found to be less than 50% in 55% of the study population. [14]

Tricuspid Regurgitation Jet Velocity

Out of all cases, it was found that majority of patients (51.3%) had tricuspid regurgitation jet velocity more than 3.4 m/s. In 42.3 % of all cases, the velocity was between 2.8 to 3.4 m/s and 6.4 % of all cases had tricuspid regurgitation jet velocity less than 2.8m/s.

Matthias Schneider et al.182 (2018) studied echocardiographic parameters in 65
patients of PH and found that moderate and severe tricuspid regurgitation (TR) was
predominantly present in patients with severe pulmonary hypertension[10]

GROUP WISE DISTRIBUTION OF CASES

In this study we found that maximum number (41%) of the cases belonged to Class II while only 5.1% of the cases belonged to Class IV. Class I had 23% of the cases and Class III had 21.7% of the cases. Also, 9% of the population belonged to Class V.

In a study carried out by **S. Harikrishnan et al.**142 (2018) in India, it was found that majority of the study participants (59%) belonged to Group II of the WHO 2013, NICE classification. While 21.2% patients belonged to Group I, 13.3% and 3.8% belonged to Group III and IV and respectively. Also, 2.4% cases belonged to Group V PH. [9,11]

Thus the group wise(etiological) distribution of cases was similar to the previous studies.

Group I

Out of the 18 patients with Group I PH, the most common etiology was idiopathic PH (33.3%) Connective tissue disease was found in 27.7% of patients and congenital heart disease in 22.2%. HIV infection and Portopulmonary hypertension were the etiology in 11.1% and 5.55% of patients respectiveIn the study carried out by **Marc Humbert et al**.85 (2006) in a total of 674 PAH patients in the year 2002, the most common etiology was idiopathic PH (39.2%). Connective tissue disease was found in 15.3% of patients and congenital heart disease in 11.3%. HIV infection was seen in 6.2% while portopulmonary hypertension in 10.4% of patients. [1,1]

Group II

In our study, in PH patients due to left heart diseases, valvular heart disease was found to be the commonest cause (41.9%) followed by left heart failure with reduced ejection fraction (35.5%) and left heart failure with preserved ejection fraction (22.6%). [1,2]

Similar etiological profile was found in the study conducted by **S. Harikrishnan et al**.142(2018), where he found valvular heart disease in 47%, left heart failure with reduced ejection in 32.1% and left heart failure with preserved ejection 17.6% of patients with Group II PH. [13]

Group III

In our study, COPD was found to be the most common lung cause in PH (41.2%), followed by ILD (29.5%) and OSA (17.6%). Bronchiectasis was seen in 11.7% cases of class 3 PH.

Benjamin H. Freed et al(2016) found that among the chronic respiratory diseases causing Pulmonary hypertension, the three major etiologies are Chronic Obstructive Pulmonary Disease (COPD), Interstitial Lung Diseases (ILD) and Sleep Disordered Breathing. They also estimated the prevalence of Pulmonary Hypertension as 20% of COPD patients with previous history of hospitalization, more than 50% in advanced COPD cases, and between 32 to 39 % in patients with Interstitial Lung Diseases. [14]

Grosse C et al147 (2010) found that restrictive lung diseases associated with pulmonary hypertension include Idiopathic Interstitial Pneumonia (like idiopathic pulmonary fibrosis) in which pulmonary hypertension is reported to occur with a prevalence as high as 46%[15]

Group IV

In this study, CTEPH and pulmonary embolism were the etiologies identified in Group IV PH. Half of the patients had CTEPH while the other half had pulmonary embolism.

The study conducted by **Nicolas Coquoz et al.**184 (2018) evaluated the incidence of CTEPH prospectively in patients with acute pulmonary embolism and depicted an incidence of CTEPH in upto 9.1% of their subjects.

Group V

In the present study, 57.1% of Group V PH had CKD (Chronic Kidney Disease), while 28.6% had Sarcoidosis and 14.3% had Sickle cell disease as the underlying etiology.

The study conducted by **Davide Bolignano et al**.185 (2013) in CKD patients showed that the prevalence of pulmonary hypertension ranges from 9%-39% in individuals with stage 5 CKD and 18.8%-68.8% in hemodialysis patients[1,6]

IV. CONCLUSION

From the present study, it can be concluded that Pulmonary Hypertension is a debilitating disease, which needs early detection, complete etiological evaluation and treatment strategisation. The middle aged females are more commonly affected with Pulmonary Hypertension. Breathlessness was the most common symptom at the time of presentation. Most frequent general examination finding was elevated JVP. Majority of the patients had mild hyoxemia in ABG and in spirometry, restrictive pattern was the most

common abnormality detected. ECG changes of right heart strain and an elevated NTProBNP level were seen in majority of the cases. The most common parenchymal abnormality in Chest X-ray and CT Thorax were reticular opacities. The ratio of diameters of Main Pulmonary Artery and Ascending Aorta was found to be more than 1 in majority of the cases. In this study, most number of cases were found to have Pulmonary Hypertension of moderate severity. Echocardiography of the patients showed dilatation of Right Atrium/ Ventricle and IVC Collapsiility of less than 50% in the majority and these findings were found to be more frequent in the more severe group of Pulmonary Hypertension. Most of the patients had a Tricuspid Regurgitation Jet Velocity of more than 3.4m/s. The most common underlying etiology was left heart diseases followed by lung diseases. Valvular heart disease was the most frequent left heart disease and COPD was the most common chronic lung disease causing Pulmonary Hypertension. Other causes are found to be less frequently involved.

As there are very limited studies done on evaluation of Pulmonary Hypertension in India, more elaborate and larger studies are needed to establish the clinical and etiological profile of Pulmonary Hypertension.

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