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ASSESSMENT ON SIGNIFICANCE OF BIOMARKERS IN DIAGNOSIS AND THERAPEUTIC MANAGEMNET OF PNEUMONIA PATIENTS IN A TERITARY CARE HOSPITAL

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ABSTRACT

Back ground: Pneumonia continues to be a major global health issue, leading to high rates of morbidity and mortality, particularly among susceptible groups. Improving patient outcomes requires a precise diagnosis and efficient therapy management. Imaging methods including chest X-rays and CT scans, as well as biomarkers like CRP, Procalcitonin, ESR, and WBC, are essential for evaluating and treating diseases.

Method: This study was conducted in a tertiary care hospital, analysing patient data based on age, gender, clinical presentation, biomarker levels, imaging findings, and treatment modalities. Statistical analysis was performed to determine associations and significance across various parameters.

Results: The findings revealed that bacterial Pneumonia was the most common type, followed by viral and fungal Pneumonia. Older adults, particularly males, were more affected. Biomarker levels varied significantly across Pneumonia types, with CRP and Procalcitonin showing diagnostic relevance. Imaging findings complemented biomarker analysis, aiding in accurate disease classification. Treatment regimens, including antibiotics, antivirals, antifungals, and combination therapies, demonstrated varying effectiveness across Pneumonia types. Biomarkers provided crucial insights into disease severity, prognosis, and treatment response. Imaging findings further strengthened diagnostic accuracy. Age, gender, and Pneumonia type influenced biomarker patterns and treatment outcomes. Combination

therapies, particularly bronchodilators with corticosteroids, exhibited enhanced therapeutic efficacy.

Conclusion: Integrating biomarker analysis with imaging techniques and tailored treatment protocols significantly improves Pneumonia diagnosis and management. This study underscores the need for biomarker-guided clinical approaches to optimize outcomes in Pneumonia care. Further research is essential to refine biomarker-based strategies for broader clinical application.

Keywords: Pneumonia, biomarkers, procalcitonin, C-reactive protein, antibiotics, antivirals, bronchodilators, corticosteroids

INTRODUCTION

Pneumonia is an infection in lungs that may be caused by bacterial, viral or fungal agents. Lungs, alveoli or air sacs become inflamed by infection. Breathing will be challenging because the alveoli swell with fluid or pus. Pneumonia is an acute respiratory infection. Pneumonia is a life-threatening infection. Pneumonia can affect anyone but older adults and children are more at risk. Pneumonia generally spread by contact with infected people. Vaccines can help prevent Pneumonia **[1-4]**.

Biomarker is a detectable molecule, structure or activity in the body that influence the occurrence of a disease. By making assumptions about the severity of the condition and how well a patient would respond to therapy, biomarkers are thought to be a useful tool for tracking an infection in patient. Furthermore, it aids in choosing a more appropriate therapy and provides earlier and more precise identification of severe death causing infection patients. Ideally, it will yield outcomes earlier than traditional culture reports. C-reactive protein (CRP), Procalcitonin and WBC count are robustly used biomarkers **[5-8]**.

MATERIALS AND METHODS

Study Protocol: Given the morbidity and mortality of Pneumonia, we are eager to learn more about it. It is a prospective observational investigation that will be carried out for six months following permission by the institution ethical committee (IEC) and institution review board (IRB). Patients who fit the study's requirements will be enrolled. Information needed for the study can be gathered from laboratory reports, medication records, and patient case sheets. Once informed consent has been obtained, the information will be examined to determine the importance of biomarkers in the diagnosis and treatment of Pneumonia patients **[9-11]**.

Study Design: It is a prospective observational study.

Study Site: The study was conducted at the Pulmonology Department, Yashoda Hospital, Secunderabad, Telangana, India.

Study Period: The study is conducted for 6 months.

Study Population: 120

Study Criteria:

Inclusion criteria:

- Patients with specific type of Pneumonia (hospital acquired and community acquired Pneumonia).
- Patients above 10 years of age.
- Both inpatients and outpatients.
- Both male and female patients.
- Patients with a conformed diagnosis of Pneumonia based on clinical presentations.
- Laboratory tests (chest x-ray, blood cultures and microbiological tests like PCR, Serology.

Exclusion criteria:

- Paediatric patients are excluded.
- Pregnant and lactating women are excluded.
- Cases with incomplete information are excluded **[12-14]**.

Statistical analysis:

Excel, SAS, and Graph Pad were used for statistical analysis. The mean ± standard deviation (SD) is used to represent all continuous data. Numbers and percentages are used to display categorical data. In order to identify significant relationships between categorical and continuous variables, inferential statistical methods such as the Chi-square test and ANOVA (Analysis of Variance) were used to compare the bacterial, viral, and fungal Pneumonia groups. P-values, which have a 95% confidence interval and a threshold of $P < 0.05$ as significant, were computed to evaluate the statistical significance of observed difference **[15-17]**.

RESULTS AND DISCUSSION

The gender-wise distribution of pneumonia patients showed a higher prevalence in males (55.37%) compared to females (44.63%). This indicates a slight male predominance in pneumonia cases. However, the *P-value* was not statistically significant, suggesting no strong association between gender and pneumonia incidence **[9, 18, 19]**.

Table 1: Distribution of study population based on gender

Gender wise distribution of patients			
Gender	**No. of Patients**	**Percentage (%)**	***P value***
Males	**67**	**55.371**	
Females	**54**	**44.628**	**0.2373**

Table 2: Distribution of study population based on age

Age wise distribution of patients			
Age	**No. of Patients**	**Percentage (%)**	***P value***
10-20	**2**	**1.652**	**0.0000000000946**
21-30	**10**	**8.264**	
31-40	**9**	**7.438**	
41-50	**13**	**10.743**	
51-60	**33**	**27.272**	
61-70	**25**	**20.661**	
71-80	**26**	**21.487**	
81-90	**3**	**2.479**	

The age-wise distribution of pneumonia patients revealed that the highest prevalence was observed in the 51–60 age group, followed by the 71–80 and 61–70 age groups, indicating increased susceptibility among older adults. Younger age groups, particularly 10–20 and 21, 30, showed significantly lower representation.

Table 3: Distribution of study population based on age-gender

Age-Gender wise distribution of patients			
	Gender		
Age	**Female**	**Male**	**P value**
10--20	**1**	**1**	**0.0522**
21-30	**6**	**4**	
31-40	**1**	**8**	
41-50	**6**	**7**	
51-60	**17**	**16**	
61-70	**7**	**18**	
71-80	**16**	**10**	
81-90	**0**	**3**	

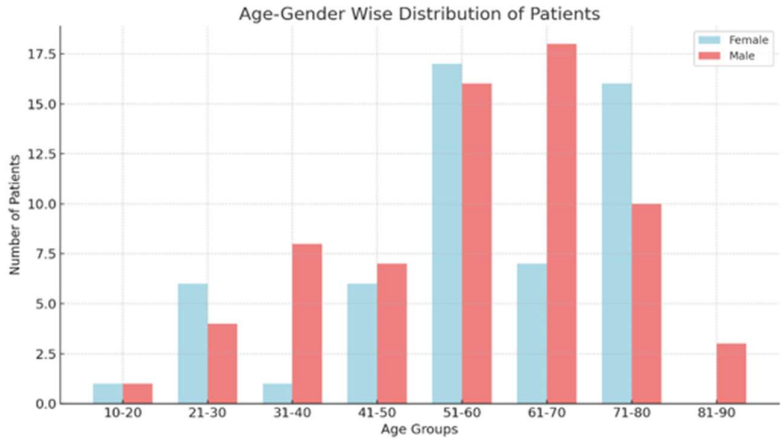

Figure 1: Distribution of study population based on age-gender

The age-gender distribution of pneumonia patients revealed variations across different age groups. In younger age groups (10–20 and 21–30), females outnumbered males, whereas in middle-aged groups (31–40 and 61–70), males

showed higher representation. In older age groups (71–80), females had a higher prevalence, while in the oldest group (81–90), only males were affected. The *P-value* (0.0522) indicated a borderline statistical significance, suggesting a potential association between age, gender, and pneumonia incidence.

Table 4: Distribution of study population-based pneumonia classification

Distribution based on Pneumonia Classification			
	No. of patients	Percentage (%)	P value
Bacterial Pneumonia	103	85.123	3.53×10^{-33}
Fungal Pneumonia	5	4.132	
Viral Pneumonia	12	9.917	

The distribution based on pneumonia classification showed that bacterial pneumonia was the most common type, accounting for the majority of cases (85.12%), followed by viral pneumonia (9.92%) and fungal pneumonia (4.13%). The *P-value* (3.53×10^{-33}) indicated a highly significant association, emphasizing the predominance of bacterial pneumonia in the study population.

Table 5: Distribution of study population based on clinical presentation of pneumonia

Clinical Presentation of patients with pneumonia				
	Bacterial	Viral	Fungal	P value
Symptoms				
SOB	103	12	5	3.53×10^{-33}
Cough with expectoration	96	8	5	1.14×10^{-32}
Fever				
High grade fever	87	9	4	5.96×10^{-29}
Low grade fever	5	2	0	0.0663
Vomiting	7	2	0	0.0131
Chest pain	13	4	0	0.0004
Micturition	3	0	2	0.2466
Haemoptysis	5	1	3	0.2636
Chills	24	3	0	5.60×10^{-9}
Abdominal pain	7	1	0	0.0046
Headache	5	1	0	0.0302
Edema	7	0	0	0.0009
Body pains	8	0	0	0.0003
Loss of appetite	8	0	0	0.0003
Loose Stool	9	0	0	0.0001
Tingling Sensation	3	0	0	0.0498
reduced urine output	6	1	0	0.0119

The clinical presentation of pneumonia patients varied across bacterial, viral, and fungal infections. Shortness of breath, cough with expectoration, and high-grade fever were the most common symptoms in bacterial pneumonia, with significant *P-values*, indicating their strong association with this type.

Table 6: Biomarkers levels in different types of pneumonia

Biomarkers levels in pneumonia				
	Bacterial	Viral	Fungal	P value
CRP	13.6±11.4	10.69±7.11	12.6±3.61	0.6264
Procalcitonin	9.09±12.31	8.16±9.61	3.11±6.08	0.0539
ESR	35.57±19.52	38.33±18.08	30.6±8.73	0.0442
WBC	14170±4634	12529±5362	12968±4442	0.3636

Biomarker analysis showed elevated CRP, procalcitonin, ESR, and WBC levels across bacterial, viral, and fungal pneumonia. ESR levels were significantly higher in viral pneumonia (p = 0.0442), while procalcitonin showed borderline significance (p = 0.0539). Overall, biomarker variations suggest their potential role in distinguishing pneumonia types.

Table 7: Distribution of study population using different drug classes by infection type

Drug Class	Bacteria	Viral	Fungal
Bronchodilators	**32**	**5**	**5**
Corticosteroids	**31**	**4**	**0**
Mucolytics	**46**	**2**	**0**
Antivirals	**45**	**12**	**0**
Antihistamines	**21**	**2**	**0**
Antifungals	**0**	**0**	**5**
Bronchodilator + Corticosteroids	**102**	**12**	**5**
Antibiotics	**102**	**12**	**5**

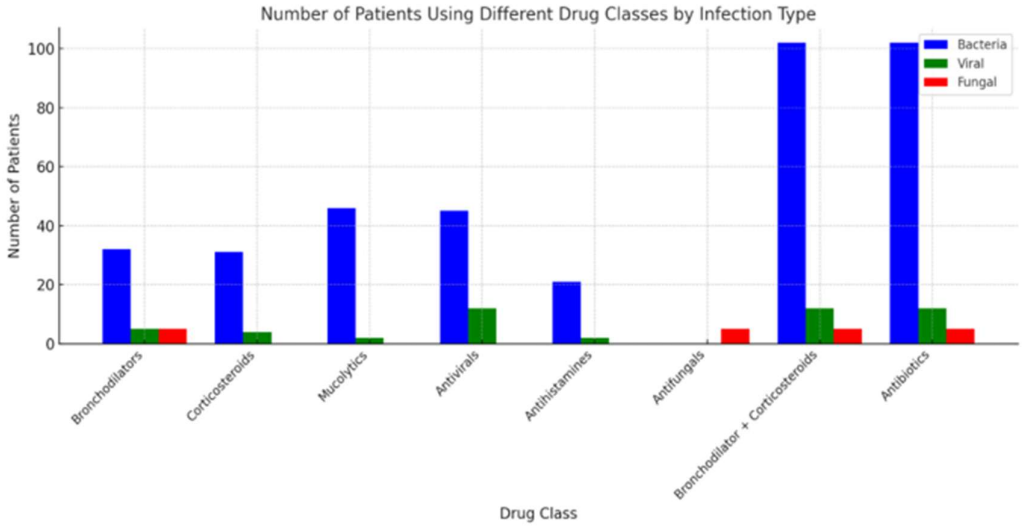

Figure 2: Distribution of study population using different drug classes by infection type

This table highlights the utilization of various drug classes across bacterial, viral, and fungal infections. Bronchodilators, antibiotics, and combination therapies (bronchodilator + corticosteroids) are widely used across all infection types, including fungal cases.

Table 8: Treatment for different types of pneumonia

Treatment	Bacterial	Fungal	Viral	P value
Bronchodilators	**32**	**0**	**5**	**3.67×10^{-11}**
Corticosteroids	**31**	**4**	**4**	**7.62×10^{-9}**
Mucolytics	**46**	**2**	**2**	**1.53×10^{-17}**
Antivirals	**45**	**4**	**12**	**8.16×10^{-11}**
Antihistamines	**21**	**2**	**2**	**5.36×10^{-7}**
Antifungals	**0**	**5**	**0**	**0.0067**
Bronchodilator + Corticosteroid	**102**	**5**	**12**	**9.14×10^{-33}**

The treatment distribution revealed significant variations across pneumonia types. Bronchodilators, corticosteroids, mucolytics, and antivirals were predominantly used in bacterial pneumonia, with highly significant *P-values*. Antifungal treatment was exclusively used in fungal pneumonia ($P = 0.0067$).

Table 9: Biomarker levels by antibiotic and pneumonia type

Antibiotics Type	Pneumonia Type	CRP (mg/L)	Procalcitonin (ng/mL)	ESR (mm/hr)	WBC (cells/µL)
Inj. Cefepime + Tazobactum + Tab. Doxycycline	Bacterial	10.6	0.88	32.75	13,460
Inj. Cefperazone + Salbactum + Tab. Doxycycline	Bacterial	13.87	6.09	29.9	14,581
Inj. Piperacillin + Tazobactum	Bacterial	7.2	2.4	20.33	10,966
Inj. Amoxicillin	Viral	18	5	35	8,500
Tab. Azithromycin	Viral	25	5.5	35	16,890
Inj. Meropenam + Tab. Doxycycline	Fungal	15.5	9.95	30	13,030
Inj. Ceftriaxone	Fungal	9.87	4.56	33	12,540

In bacterial pneumonia, combinations such as Cefepime + Tazobactam + Tab. Doxycycline and Cefperazone + Sulbactam + Tab. Doxycycline showed elevated CRP and WBC levels. Viral pneumonia cases treated with Amoxicillin and Azithromycin exhibited moderate biomarker levels, with Azithromycin showing notably high WBC counts. Fungal pneumonia cases treated with Meropenem + Tab. Doxycycline and Ceftriaxone demonstrated elevated procalcitonin levels.

Table 10: Biomarker levels by treatment and pneumonia type

Treatment Type	Pneumonia Type	CRP (mg/L)	Procalcitonin (ng/mL)	ESR (mm/hr)	WBC (cells/µL)
Bronchodilators	Bacterial	15.2	10.74	31.06	13,818
	Viral	12.1	3.37	32.8	11,878
	Fungal	-	-	-	-
Corticosteroids	Bacterial	16.3	10.96	37.48	13,312
	Viral	14.8	11	40.75	10,795
	Fungal	10.2	0.4	34.5	11,810
Mucolytic	Bacterial	14.6	8.36	36.39	14,513
	Viral	17.2	14.55	59	17,820
	Fungal	12.4	0.43	34	8,200
Antivirals	Bacterial	13.8	9.61	37.62	13,662
	Viral	12.1	8.16	38.33	12,529
	Fungal	10.2	0.4	34.5	11,810
Antifungals	Fungal	12.6	3.12	30.6	12,968
Antihistamines	Bacterial	14.2	9.99	36.19	14,053
	Viral	10.6	0.11	35.5	8,260
	Fungal	11.8	0.43	34	8,200
Combination (Bronchodilator + Corticosteroid)	Bacterial	15.5	9.14	35.79	14,176
	Viral	13.9	8.16	38.33	12,529
	Fungal	11.2	3.12	30.6	12,968

The analysis of treatment types across pneumonia classifications revealed distinct biomarker variations. In bacterial pneumonia, treatments like Bronchodilators,

Corticosteroids, and Mucolytics showed elevated CRP, Procalcitonin, and WBC levels. Viral pneumonia cases demonstrated higher ESR levels with Mucolytics and Corticosteroids, while fungal pneumonia treated with Antifungals and combination therapies exhibited moderate CRP and WBC levels but lower Procalcitonin levels.

Table 11: Biomarkers levels by X-ray and CT findings

X-ray Findings	CT Findings	CRP (mg/L)	Procalcitonin (ng/mL)	ESR (mm/hr)	WBC (cells/µL)
Opacification of lung tissue	**Patchy consolidations with ground glass opacities**	**27.2**	**42.9**	**20**	**12020**
Lung infiltrates, pleural effusions	**Ground glass opacification in lower lobe**	**10**	**0.25**	**16**	**17600**
Patchy consolidations in lung tissue	**Consolidations with ground glass opacities lung**	**11**	**0.25**	**15**	**14570**
Nodular opacities in lung tissues	**Upper lung dense consolidations, mild pleural effusion**	**24.2**	**2.3**	**24**	**17250**
Nodular opacities, patchy appearance	**B/L Consolidation with ground glass opacities**	**8.63**	**0.105**	**32**	**6380**

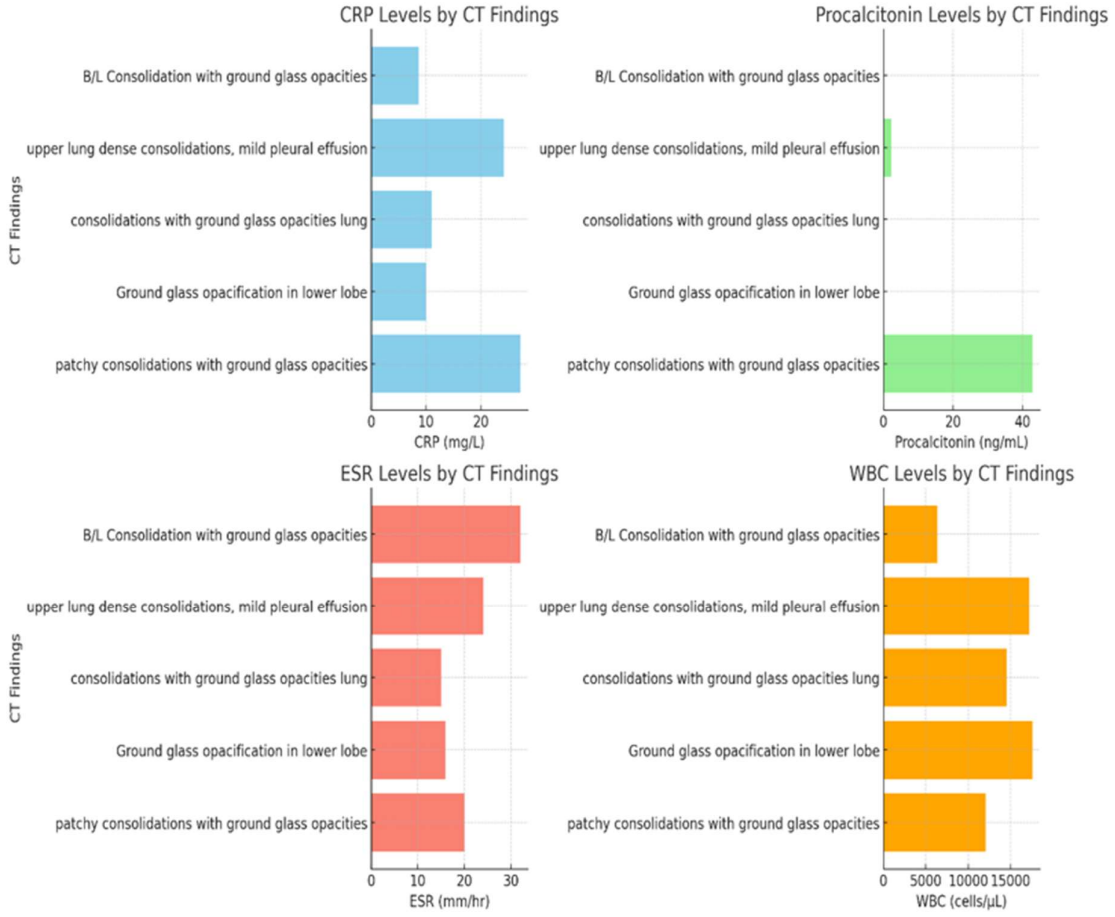

Figure 3: Biomarkers levels by CT findings

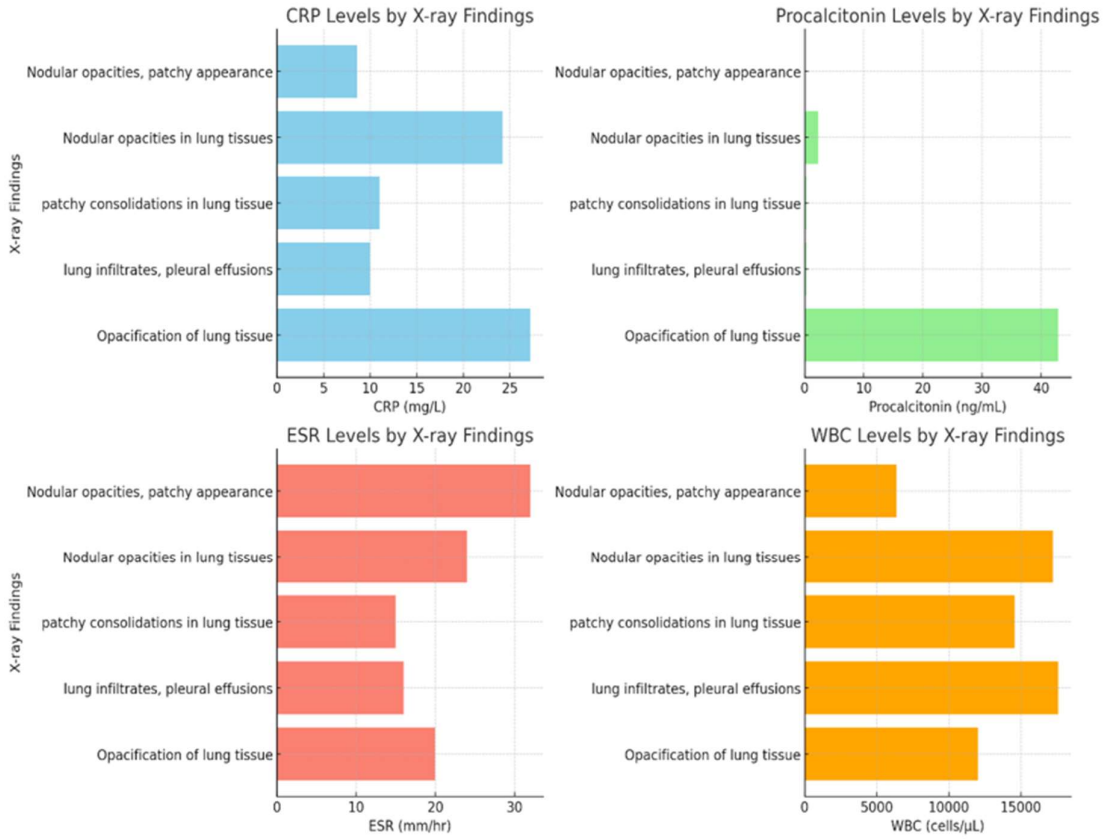

Figure 4: Biomarkers levels by X-ray findings

Radiological findings in pneumonia cases revealed significant correlations with biomarker levels. X-ray observations, including lung opacification, nodular opacities, and pleural effusions, were complemented by CT findings such as patchy consolidations, ground glass opacities, and dense lung consolidations.

The Study highlighted the major significance of biomarkers in diagnosis, prognosis and therapeutic treatment of Pneumonia in a single centred tertiary care hospital. Results revealed the age and gender analysis that older adults, mainly males are more prone to pneumonia, needed care for preventive measures. Most common kind of pneumonia was bacterial and followed by fungal and viral pneumonia which had their own unique biomarkers profiles and clinical symptoms. To distinguish between different types of pneumonia evaluated the severity of illness, track the treatment outcomes and the clinical symptoms. Biomarkers (CRP, Procalcitonin, ESR and WBC) of the patients. Biomarkers analysis along with imaging results (x ray and CT scan) provided important diagnosis Support. Different treatment strategies were followed based on type of treatment. Treatment strategies differed depending on the type of pneumonia along with supportive therapies,

antivirals, antifungals, and antibiotics which is important in enhancing patient outcome. In treating severe instances, combing medications showed improved efficacy. Biomarkers analysis combined with clinical evaluation and imaging can greatly enhance the diagnosis of pneumonia minimize treatment delays and improved patient care. For improved disease management on going forward biomarkers guided clinical regimen should be implemented. To enhance healthcare outcomes more research is required to find new biomarkers and better pneumonia treatment approaches **[20-26]**.

Limitations

- This study was conducted only for a period of 6 months and long-term study may show varied response.
- This study is confined to a minimum sample size of 120 patients and may not reflect the entire population.
- This study involves heterogeneous population with varied physical and economic status.

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