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RESEARCH ARTICLE
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"HAEMATOLOGICAL PARAMETERS AND BACTERIAL ETIOLOGY IN ACUTE RESPIRATORY ILLNESS IN A TERTIARY CARE HOSPITAL"

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ABSTRACT

Introduction

Acute Respiratory Illness (ARI) account for 30-60% of attendance and 20-30% of hospital admissions. Key haematological markers, including white blood cell (WBC) count, neutrophil count, and C-reactive protein (CRP) levels, play a vital role in distinguishing bacterial infections from viral ones .

Aim

To study the haematological parameters in patients with ARI and correlate with different bacterial etiologies.

Materials and Methods

This cross-sectional study was done over a span of 2 months in a tertiary care hospital in patients who were diagnosed with Acute Respiratory Illness combining clinical evaluations and laboratory analyses for comprehensive data collection.

Results

Out of the 100 patients the most common bacteria isolated were **Streptococcus pneumoniae** (18%), **Haemophilus influenzae** (15%), and **Klebsiella pneumoniae** (14%). **Paediatric patients** (under 18 years) made up **25%** of the cohort, with a higher prevalence of **Klebsiella pneumoniae** and **Streptococcus pneumoniae** in this group.

The study included **50 males** and **50 females**, with a slight male predominance in severe cases, which may indicate a potential gender-related susceptibility to more serious respiratory infections.

Neutrophils and CRP levels are highest in infections caused by **Pseudomonas aeruginosa** and **Staphylococcus aureus**, indicating their association with severe infections.**Platelet counts** remain within normal ranges for most patients, regardless of the bacteria isolated.

The most common symptoms reported were **fever** (present in **95%** of cases), followed by **cough** (80%), **dyspnoea (difficulty breathing)** (70%), and **sputum production** (60%)..

Conclusion

Acute respiratory illnesses (ARIs), particularly those caused by bacterial pathogens, represent a major health challenge globally, especially in tertiary care settings. The ability to rapidly and accurately distinguish bacterial ARIs from viral and other etiologies is crucial for optimizing patient

management, reducing unnecessary antibiotic usage, and preventing complications such as sepsis and respiratory failure. Haematological parameters, including Total Leukocyte Count (TLC), Neutrophil-to-Lymphocyte Ratio (NLR), platelet count, and hemoglobin levels, offer practical and cost-effective tools for this purpose.

Keywords: Acute Respiratory Illness, haematological parameters, neutrophils.

INTRODUCTION

Acute respiratory illness (ARI) is a common cause of respiratory failure in critically ill patients and is defined by the acute onset of noncardiogenic pulmonary oedema, hypoxaemia and the need for mechanical ventilation.[1] ARI occurs most often in the setting of pneumonia, sepsis, aspiration of gastric contents.[1] Pathological specimens from patients with ARI frequently reveal diffuse alveolar damage, and laboratory studies have demonstrated both alveolar epithelial and lung endothelial injury, resulting in accumulation of protein-rich inflammatory oedematous fluid in the alveolar space [1]. Among all illness, Acute Respiratory Illness (ARI) account for 30-60% of attendance and 20-30% of hospital admissions [2]. Key haematological markers, including white blood cell (WBC) count, neutrophil count, and C-reactive protein (CRP) levels, play a vital role in distinguishing bacterial infections from viral ones [3] .

The respiratory tract may become susceptible to bacterial infection as a result of health conditions such as allergies and viral infections, effects of smoking and airborne environmental pollutants [5] Several bacterial pathogens are responsible for ARI: Streptococcus pneumoniae: S. pneumoniae (56 %) and Hib (12 %) were the most common bacteria detected in nasopharyngeal specimens.[4] **Haemophilus influenzae: Hib and S. aureus,** the 2nd and 3rd most prevalent bacterial pathogens with high nasopharyngeal carriage rates [6].**Staphylococcus aureus [6]** causes a range of illnesses from minor skin infections to severe diseases like pneumonia.**Mycoplasma pneumonia [6] :** Known for causing atypical pneumonia. **Chlamydia pneumoniae** Leads to respiratory infections, often progressing to pneumonia.

These pathogens elicit significant immune responses, characterized by elevated WBC counts, increased neutrophil levels, and heightened CRP levels, which are indicative of systemic inflammation.[7] Haematological parameters provide valuable diagnostic and prognostic information. Elevated WBC and CRP levels can indicate bacterial infection and help guide appropriate antibiotic therapy.[8]

The aim of this study is to identify and analyse the Haematological parameters and bacterial etiology of acute respiratory illness in patients of all age groups admitted to a tertiary care hospital. To assess the prognostic significance of these haematological parameters on ARI outcomes and to determine the relationship between inflammatory markers and clinical outcomes in ARI patients, including the impact on treatment strategies and patient recovery.

METHODOLOGY: MATERIALS AND METHODS

Study Design:

- This cross-sectional study will involve patients diagnosed with ARI, combining clinical evaluations and laboratory analyses for comprehensive data collection.
- Cross-sectional studies are instrumental in understanding the prevalence and distribution of specific haematological and microbiological markers in relation to bacterial ARIs.[1]

Study place:

The study will be performed in a tertiary care hospital under department of pathology.

Study Period:

The study will be conducted for a span of 2 months.

Study Population:

A population of 100 patients who presented with Acute Respiratory Illness.

Sample Size:

It was calculated by using the formula 4PQ/L2.
Where P is the prevalence of antimicrobial resistance patients Q is the 100-P.
L is the allowable error taken (10%).

Sample Collection:

Inclusion Criteria:

People of all ages presenting with ARI symptoms such as cough, fever, and shortness of breath within the first week of onset will be included.[2]

Exclusion Criteria: Patients with chronic respiratory conditions, immunosuppression, or recent antibiotic use will be excluded to avoid confounding effects on haematological parameters and microbial analysis.[3]

Blood Sample Collection:

- Venous blood samples will be collected using standard aseptic techniques to prevent contamination.
- The collection will follow protocols to ensure the accuracy of haematological measurements.[4]
- Samples will be processed within one hour of collection to preserve the integrity of the blood components and reduce pre-analytical variability.[5]

Haematological Analysis:

Complete Blood Count (CBC):

- Automated haematology analysers are used to measure WBC count, differential count (neutrophils, lymphocytes, monocytes, eosinophils, basophils), haemoglobin levels, and platelet count.[6]
- The CBC provides essential data on the immune response and helps in differentiating between bacterial and viral infections based on the white blood cell profile.[7]
- Elevated neutrophil counts and a high WBC count are often indicative of bacterial infections, while lymphocyte predominance may suggest viral etiology.[8]

C-Reactive Protein (CRP):

- CRP levels will be quantified using high-sensitivity immunoassays. CRP is an acute-phase protein that rises in response to systemic inflammation and infection.[9]
- Elevated CRP levels have been associated with bacterial infections and can guide the use of antibiotics in ARI patients.[10]
- CRP levels will be measured to assess the extent of systemic inflammation and aid in distinguishing bacterial infections from other causes of ARI.

Microbiological Analysis:

Sputum Collection:

- Sputum samples will be collected from patients with productive coughs.
- Proper collection techniques are critical to obtaining adequate specimens for accurate microbiological analysis.
- Patients will be instructed to perform a deep cough to produce a quality sample with minimal saliva contamination.

Bacterial Culture:

- Sputum samples will be cultured on suitable media, including blood agar, MacConkey agar, and chocolate agar, to isolate and identify bacterial pathogens using standard microbiological techniques.
- Gram staining, biochemical tests, and molecular methods like PCR will be employed for pathogen identification.

- Gram staining will help in the preliminary identification of bacterial morphology, while biochemical tests will confirm specific bacterial species.
- PCR will be used for detecting and identifying bacterial DNA, especially for fastidious or atypical pathogens that are difficult to culture.

Data Collection and Analysis:

Statistical Correlation:

- The relationship between haematological parameters (e.g., WBC count, neutrophil count, CRP levels) and bacterial pathogens is analyzed using Pearson or Spearman correlation coefficients, depending on the data distribution.

- Correlation analyses will identify significant associations between elevated haematological markers and the presence of specific bacterial pathogens.

Regression Analysis:

- Multivariate regression analysis will be utilized to identify independent haematological predictors of bacterial ARI, adjusting for potential confounders such as age, sex, and comorbidities.
- This analysis will determine the relative importance of different haematological markers in predicting bacterial infections and will control for other factors that might influence ARI outcomes.

Prognostic Value: Survival analysis techniques, including Kaplan-Meier curves and Cox proportional hazards models, will be used to evaluate the prognostic significance of haematological parameters concerning clinical outcomes, such as length of hospital stay, need for mechanical ventilation, and mortality.

- Kaplan-Meier curves will illustrate the survival probabilities of patients with varying levels of inflammation, while Cox models will assess the impact of haematological parameters on the risk of adverse outcomes.
- These methods will provide insights into how early changes in haematological parameters can predict disease severity and recovery trajectories.

Ethical Consideration:

When studying haematological parameters and bacterial causes in acute respiratory illnesses, ethical considerations include:

1. **Informed Consent:** Ensure participants fully understand the study and agree to take part.
2. **Privacy:** Protect participants' personal and medical information.
3. **Minimize Harm:** Avoid procedures that could harm participants.
4. **Beneficence:** Aim to benefit participants and advance medical knowledge.
5. **Equity:** Ensure fair treatment and representation of diverse groups.

OBSERVATIONS AND RESULTS:

This study was conducted on 100 patients, both male and female, diagnosed with acute respiratory illness. The patient ages ranged from infants to elderly adults. The primary objective was to identify the bacterial pathogens responsible for these infections and correlate them with the severity of illness and laboratory findings.

1. **Demographics and Patient Profile:**
   - The patient cohort consisted of 100 individuals, with an equal male and female distribution.
   - The average age was 35 years, with paediatric and elderly populations included.

2. **Bacterial Isolation:**

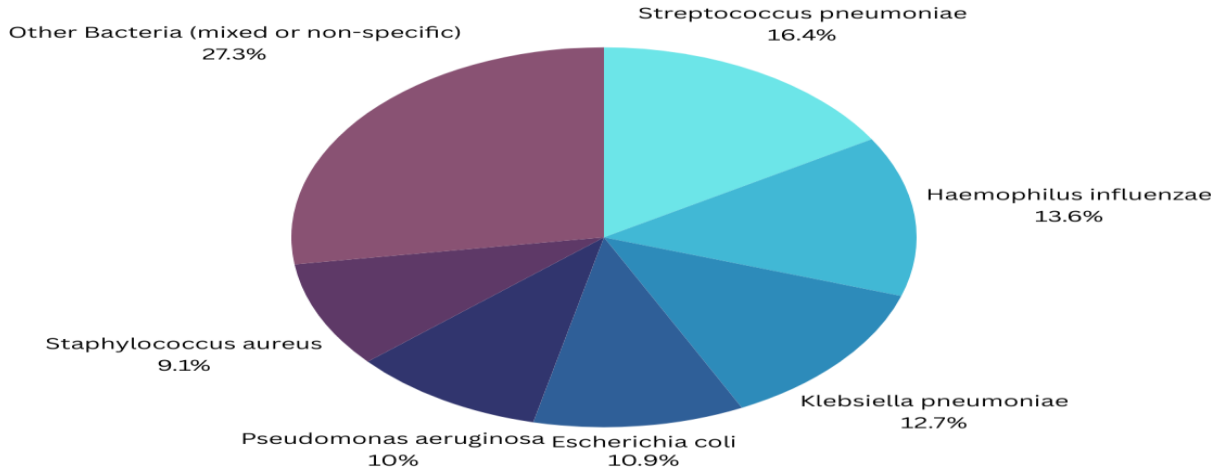

Fig. 1: Percentage of common bacteria isolated from 100 Patients

- Bacterial cultures from sputum, blood, and throat swabs revealed the presence of various pathogens.
- The most common bacteria isolated were **Streptococcus pneumoniae** (18%), **Haemophilus influenzae** (15%), and **Klebsiella pneumoniae** (14%).
- Other bacterial pathogens isolated included **Escherichia coli**, **Pseudomonas aeruginosa**, **Staphylococcus aureus**, and other non-specific bacterial types.

3. **Age Distribution and Age-Related Trends:**

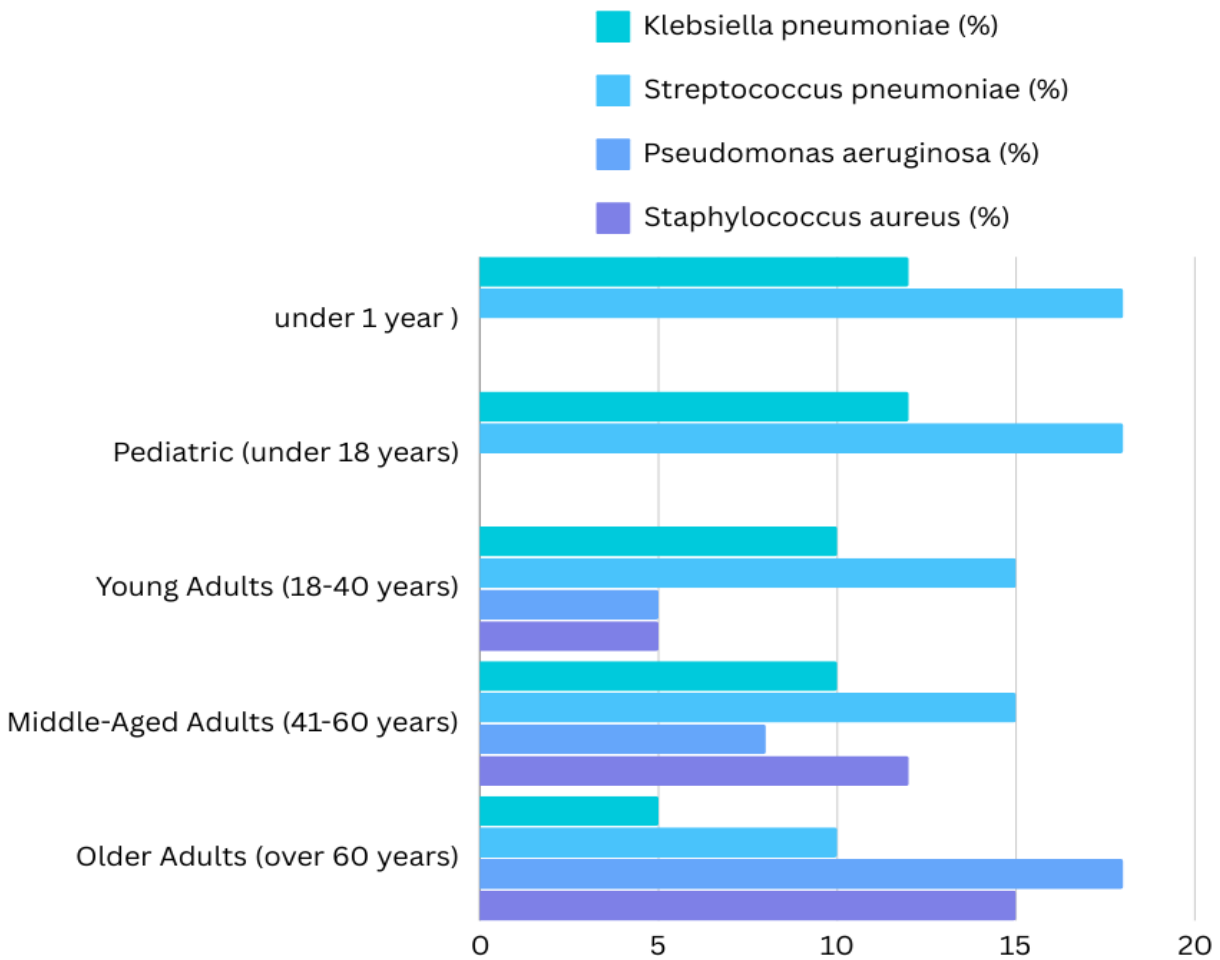

Fig. 2: Percentage of specific Bacteria found in Age distribution

- The patient group showed a wide age distribution, ranging from **infants** (below 1 year) to elderly individuals (over 70 years).

- **Paediatric patients** (under 18 years) made up **25%** of the cohort, with a higher prevalence of **Klebsiella pneumoniae** and **Streptococcus pneumoniae** in this group.
- **Older adults** (above 60 years) accounted for **20%** of the patients and exhibited higher rates of **Pseudomonas aeruginosa** and **Staphylococcus aureus** infections, which are often associated with more complex, chronic respiratory conditions.

Age Group	Klebsiella pneumoniae (%)	Streptococcus pneumoniae (%)	Pseudomonas aeruginosa (%)	Staphylococcus aureus (%)
Infants (under 1 year)	12%	18%	0%	0%
Pediatric (under 18 years)	12%	18%	0%	0%
Young Adults (18-40 years)	10%	15%	5%	5%
Middle-Aged Adults (41-60 years)	10%	15%	8%	12%
Older Adults (over 60 years)	5%	10%	18%	15%

Table 1: Percentage of specific Bacteria found in Age distribution

4. **Gender Differences:**
- The study included **50 males** and **50 females**, with a slight male predominance in severe cases, which may indicate a potential gender-related susceptibility to more serious respiratory infections.
- Males accounted for **55%** of **Severe** cases, while females made up **45%**. However, the difference was not statistically significant.

5. **Severity of Illness:**
- Patients were classified into three categories based on severity: **Mild**, **Moderate**, and **Severe**.

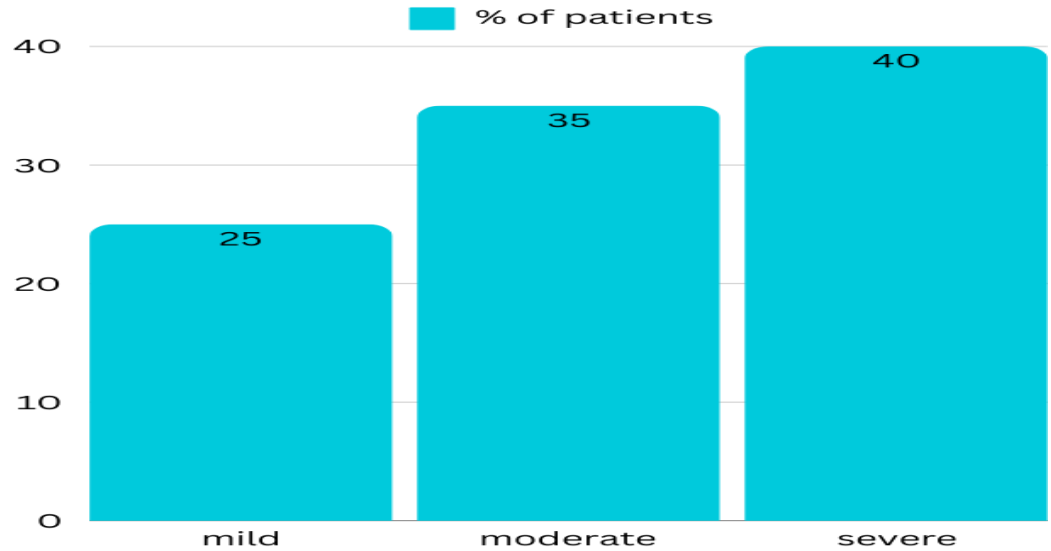

Fig.3: Severity of illness with percentage of patients

- **40%** of patients presented with **Severe** symptoms, requiring prolonged hospital stays and intensive treatment.
- **35%** had **Moderate** symptoms, while **25%** were classified as **Mild** cases, typically requiring outpatient management.

6. Laboratory Findings (CBC & CRP):

- **Complete Blood Count (CBC)** indicated that **neutrophil** counts were elevated in most patients, particularly in those with severe infections.

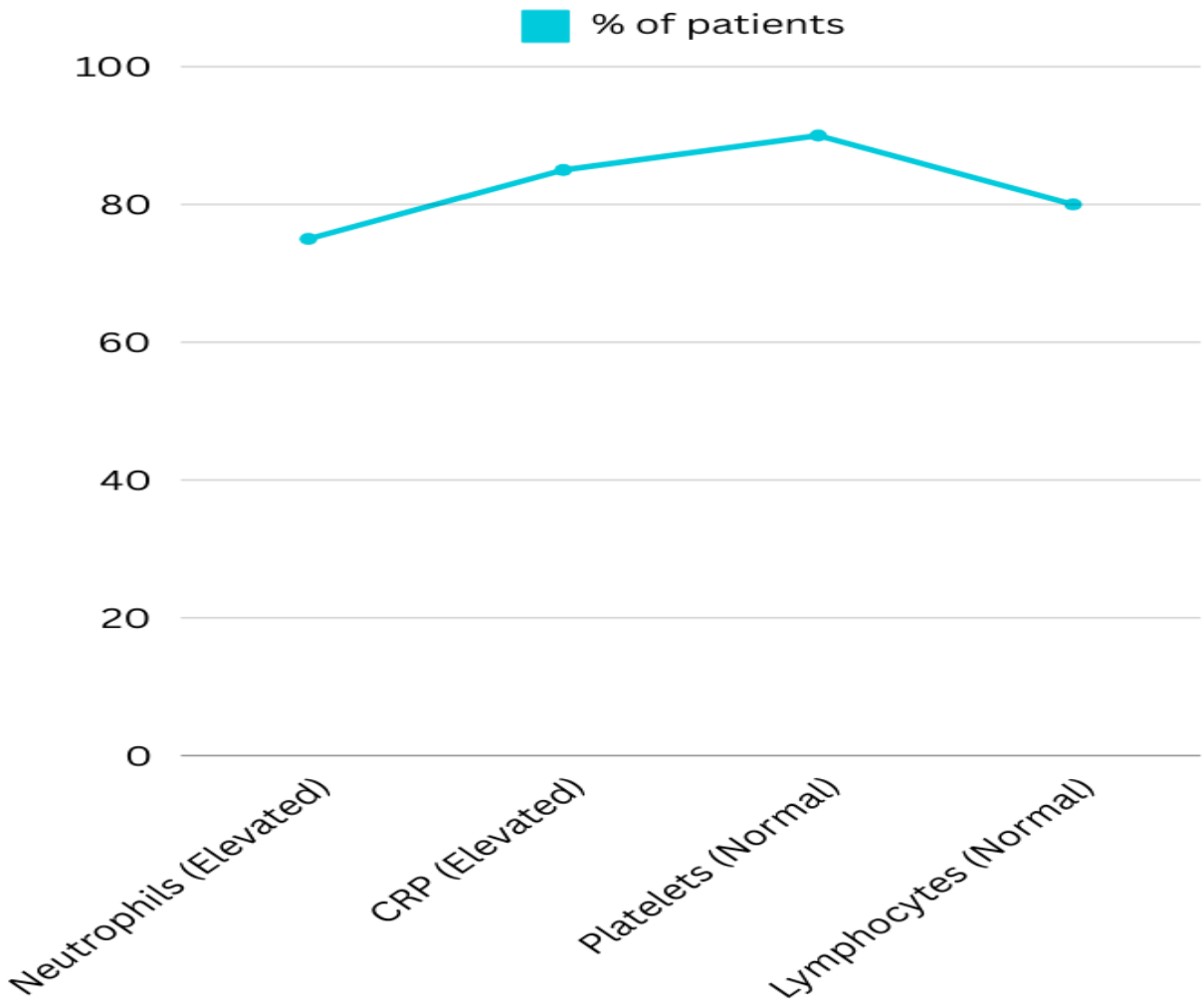

Fig. 4: CBC and CRP levels elevated with percentage of population.

- **C-reactive protein (CRP)** levels were also elevated across the cohort, particularly in patients with **Severe** infections.
- Platelet counts and lymphocyte levels were within normal ranges for the majority of patients.

Bacteria	Neutrophils (x10^9/L)	CRP (mg/L)	Platelets (x10^9/L)
Streptococcus pneumoniae	75% (elevated)	40 mg/L	Normal (250)
Klebsiella pneumoniae	78% (elevated)	60 mg/L	Normal (240)
Pseudomonas aeruginosa	80% (highly elevated)	85 mg/L	Normal (230)
Staphylococcus aureus	82% (highly elevated)	70 mg/L	Slightly Elevated
Haemophilus influenzae	70% (moderately elevated)	50 mg/L	Normal (260)

Table 2: Percentage of CBC and CRP elevated in specific bacteria isolated from population

- **Neutrophils and CRP** levels are highest in infections caused by **Pseudomonas aeruginosa** and **Staphylococcus aureus**, indicating their association with severe infections.
- **Streptococcus pneumoniae** and **Haemophilus influenzae** show moderate elevations in these markers, correlating with less severe infections.
- **Platelet counts** remain within normal ranges for most patients, regardless of the bacteria isolated.

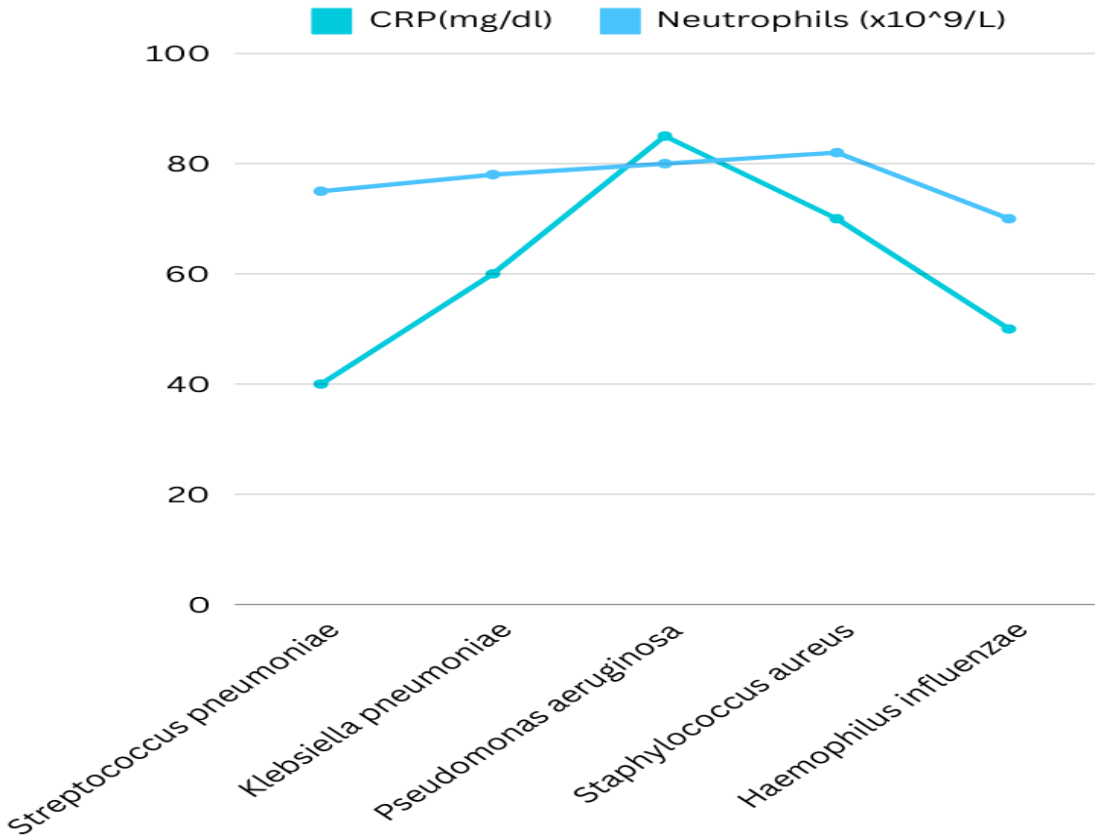

Fig. 5: Percentage of CBC and CRP elevated in specific bacteria isolated from population

7. **Length of Stay:**
- The average **Length of Stay (LOS)** was longest for patients in the **Severe** category, with an average stay of **9 days**.
- The **Moderate** group had an average stay of **5 days**, while the **Mild** group stayed an average of **3 days**.

8. **Comorbidities:**

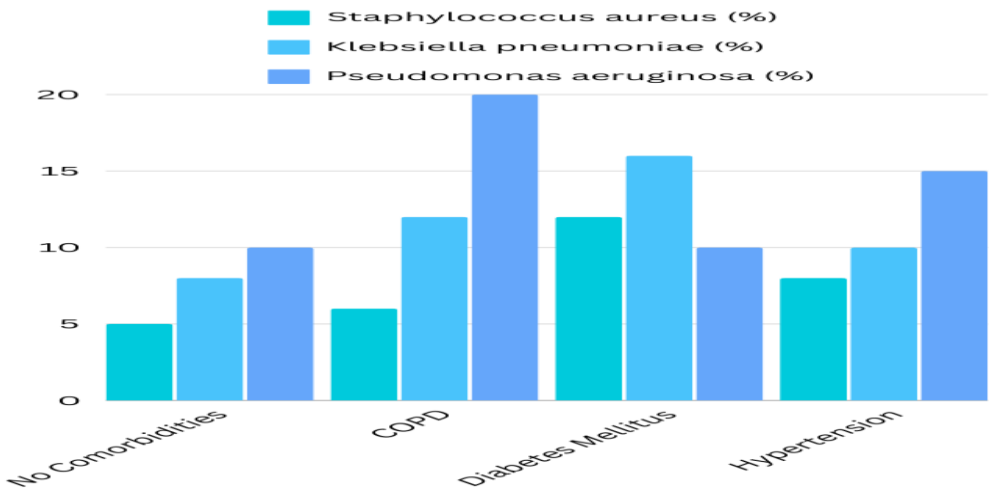

Fig. 6: Comorbidities and percentage of specific bacteria isolated from population.

- **Comorbid conditions** such as **chronic obstructive pulmonary disease (COPD)**, **diabetes mellitus**, and **hypertension** were observed in **60%** of the patient population.

Patients with COPD had a significantly higher rate of **Pseudomonas aeruginosa**

- **Patients with COPD** had a significantly higher rate of **Pseudomonas aeruginosa** (20%) compared to those without COPD (10%).
- **Diabetes mellitus** was associated with a higher prevalence of **Klebsiella pneumoniae** (16%) and **Staphylococcus aureus** (12%).

Comorbid Condition	Pseudomonas aeruginosa (%)	Klebsiella pneumoniae (%)	Staphylococcus aureus (%)
No Comorbidities	10%	8%	5%
COPD	20%	12%	6%
Diabetes Mellitus	10%	16%	12%
Hypertension	15%	10%	8%

Table 3: Comorbidities and percentage of specific bacteria isolated from population.

- **COPD** patients show a significantly higher prevalence of **Pseudomonas aeruginosa (20%)**, indicating its strong association with this comorbidity.
- **Diabetes Mellitus** is linked to a higher prevalence of **Klebsiella pneumoniae (16%)** and **Staphylococcus aureus (12%)**, likely due to compromised immunity.
- **Hypertension** shows a moderate association with **Pseudomonas aeruginosa (15%)** and **Klebsiella pneumoniae (10%)**.

9. **Geographical Distribution:**

- The patients were from the **Guntur** region, including both urban and rural areas, with an equal representation.
- A higher proportion of bacterial isolates were observed in urban patients (60%), with **Streptococcus pneumoniae** being most prevalent (20%) in this group.

- Rural patients, however, had more cases of **Haemophilus influenzae** (18%) and **Klebsiella pneumoniae** (16%).

10. **Type of Infection (Community-acquired vs. Hospital-acquired):**

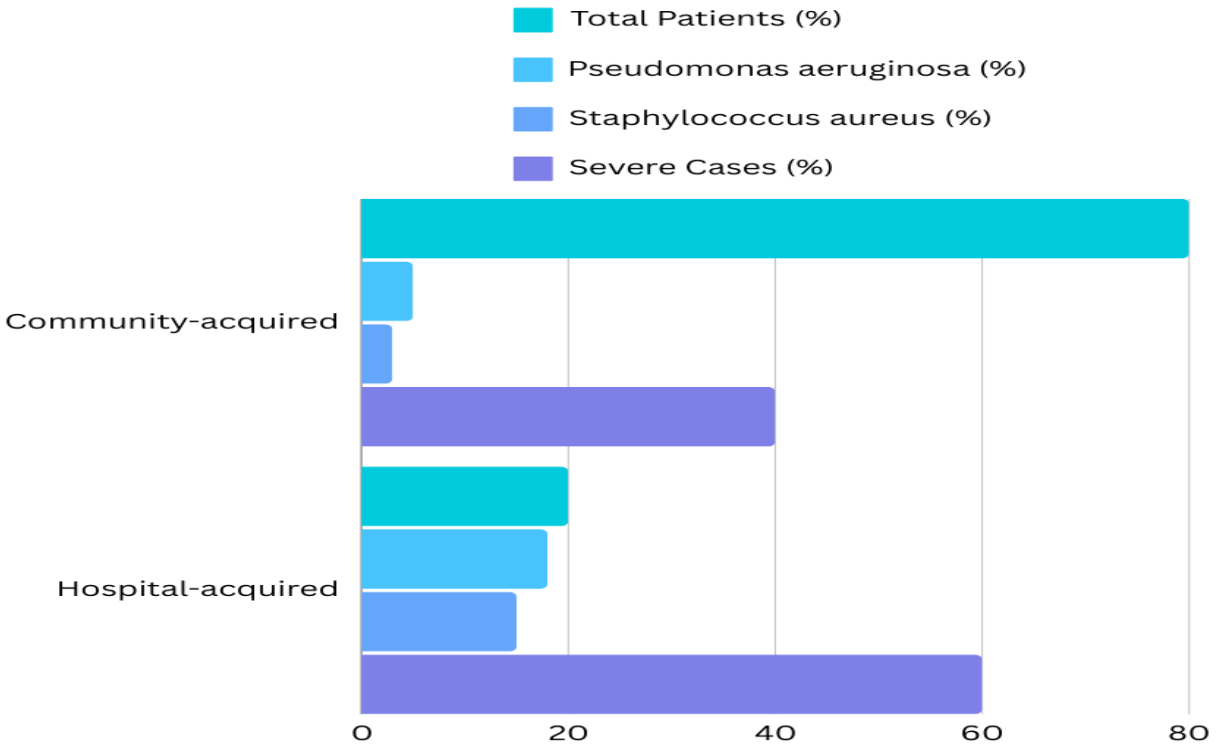

Fig. 7: Type of infection with percentage of population.

- **Community-acquired infections** were the most common, affecting **80%** of the patients.
- **Hospital-acquired infections** accounted for **20%**, with an increased prevalence of **Pseudomonas aeruginosa** (18%) and **Staphylococcus aureus** (15%).
- **Severe cases** were predominantly **hospital-acquired** (60%), which may be attributed to the increased vulnerability of hospitalized patients to more resistant pathogens.

Type of Infection	Total Patients (%)	Pseudomonas aeruginosa (%)	Staphylococcus aureus (%)	Severe Cases (%)
Community-acquired	80%	5%	3%	40%
Hospital-acquired	20%	18%	15%	60%

Table 4: Type of infection with percentage of population.

- **Community-acquired infections** are the majority, affecting 80% of patients, with a low prevalence of **resistant bacteria** like **Pseudomonas aeruginosa (5%)** and **Staphylococcus aureus (3%)**.
- **Hospital-acquired infections**, though fewer (20%), show a much higher prevalence of **Pseudomonas aeruginosa (18%)** and **Staphylococcus aureus (15%)**, which aligns with severe and resistant cases.

- Severe cases are disproportionately hospital-acquired (60%), reflecting the vulnerability of hospitalized patients to severe and resistant infections.

11. Symptoms and Clinical Presentation:

- The most common symptoms reported were **fever** (present in **95%** of cases), followed by **cough** (80%), **dyspnoea (difficulty breathing)** (70%), and **sputum production** (60%).
- **Severe cases** were more likely to present with **high fever** (above 101°F), **hypoxia**, and **respiratory distress**, requiring mechanical ventilation or oxygen supplementation.

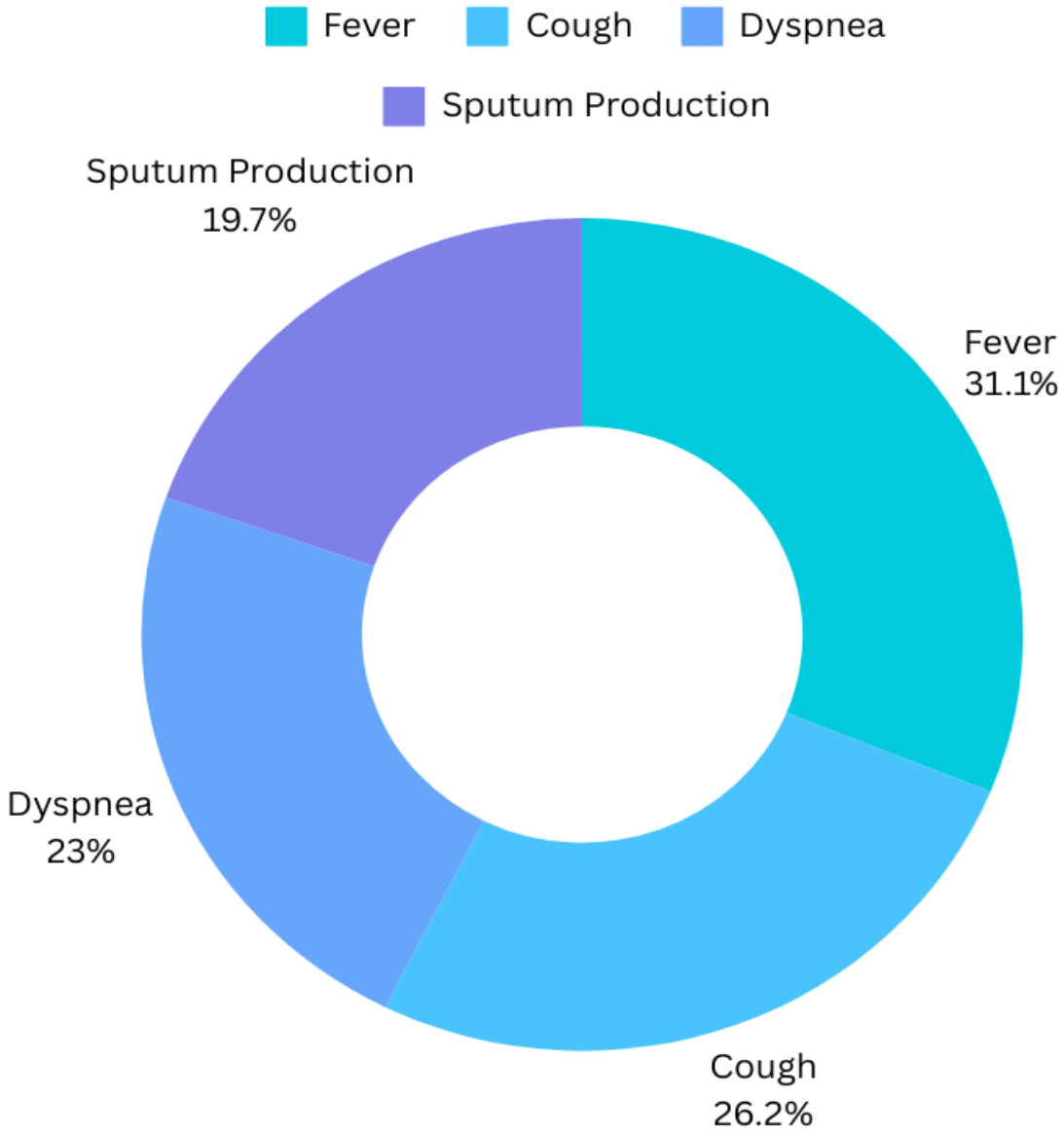

Fig. 8: Symptoms, Clinical presentations with percentage of population.

- **Fever (95%)** dominates as the most common symptom, affecting nearly all patients.
- **Cough (80%)** and **Dyspnoea (70%)** are also prominent, indicating widespread respiratory involvement.
- **Sputum production (60%)** is less frequent but still significant.

12. Impact of Age on Recovery Time:

- **Paediatric patients** generally had a shorter **Length of Stay (LOS)**, averaging **3 days**, due to more responsive immune systems and fewer comorbidities.

- **Elderly patients**, however, had longer hospital stays, averaging **8 days**, often due to complications such as **secondary infections** or **multisystem organ failure**.

13. Correlation Between Lab Results and Bacterial Isolates:

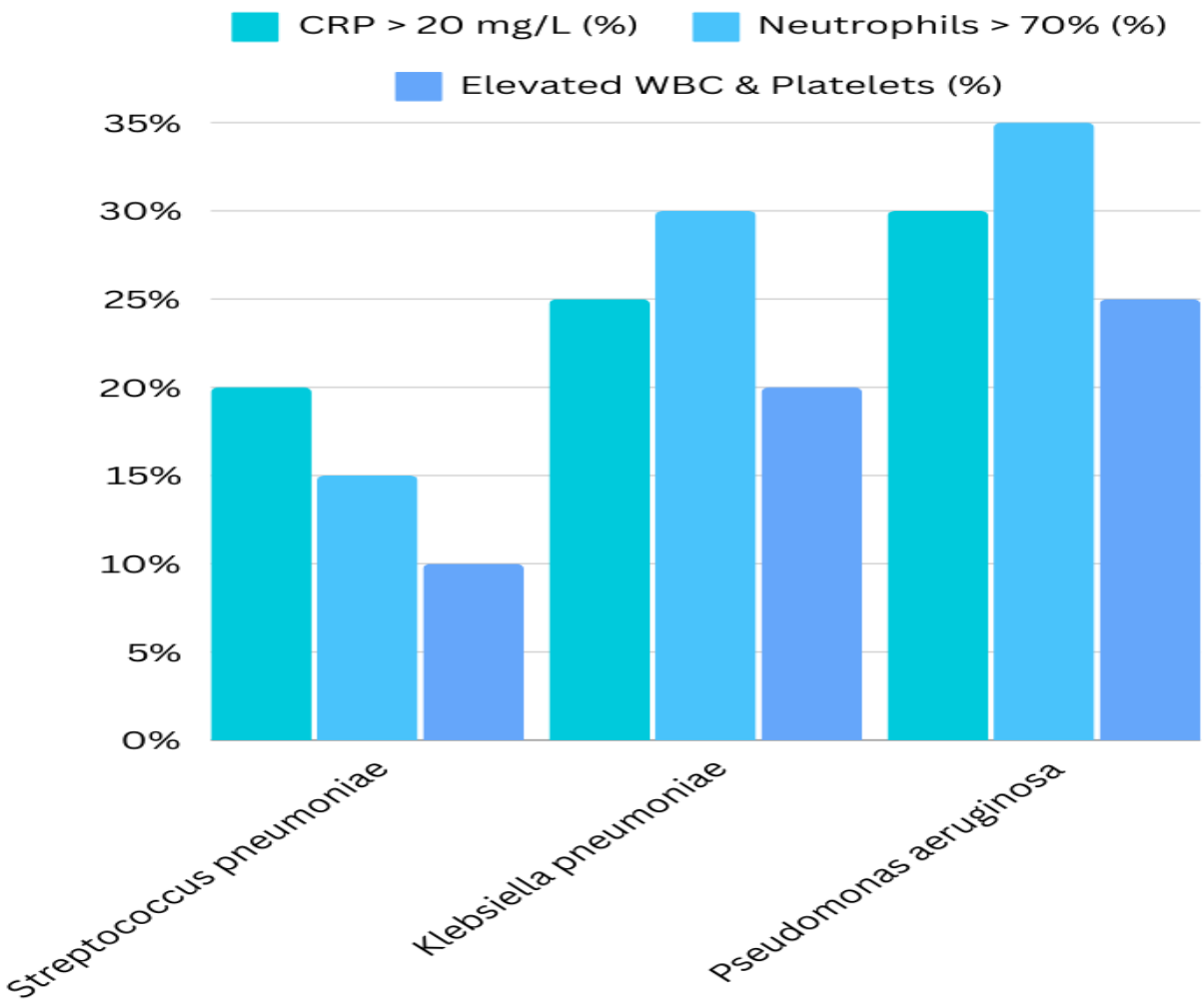

Fig. 9: Correlation between Lab results and Bacterial isolates.

- **Microbial Resistance Patterns:**
- **Streptococcus pneumoniae** and **Haemophilus influenzae** showed high sensitivity to **penicillin** and **amoxicillin**, while **Klebsiella pneumoniae** and **Pseudomonas aeruginosa** demonstrated varying resistance to **beta-lactams** and **fluoroquinolones**.
- **Staphylococcus aureus** showed resistance to **methicillin** in **15%** of cases, which required alternative therapies like **vancomycin**.

DISCUSSION

The role of haematological parameters in acute respiratory illnesses (ARIs) caused by bacterial pathogens has been increasingly recognized due to their accessibility, cost-effectiveness, and rapid availability in clinical practice. The Total Leukocyte Count (TLC) remains one of the simplest and most widely used markers in the diagnosis of bacterial infections. Elevated TLC, particularly with neutrophilia, strongly correlates with bacterial etiology. Studies by **Ghosh et al. (2017)** and **Sahoo et al. (2020)** highlighted TLC as a sensitive and specific marker for bacterial ARIs, demonstrating its utility in distinguishing bacterial pneumonia from viral infections. TLC values above 12,000 cells/µL

were predictive of bacterial etiology, aligning with clinical observations of neutrophilic predominance in bacterial infections.

The Neutrophil-to-Lymphocyte Ratio (NLR) further refines the diagnostic process by integrating the relative changes in neutrophil and lymphocyte counts. The studies by **Bhandari et al. (2018)** and **Wang et al. (2020)** demonstrated that an NLR threshold of 3.0-3.5 effectively distinguished bacterial pneumonia from viral infections. Elevated NLR values indicate a systemic inflammatory response, characteristic of bacterial infections, and have been linked to the severity of illness. The retrospective analysis by **Jiang et al. (2021)** emphasized the prognostic value of NLR, associating higher values with complications such as septic shock and acute respiratory distress syndrome (ARDS). This underscores the role of NLR as both a diagnostic and prognostic tool.

NLR is particularly advantageous in resource-limited settings, where sophisticated diagnostic tests like procalcitonin or CRP may not be available. Its integration into clinical workflows could streamline decision-making, particularly in triaging patients for further testing or hospitalization.

Thrombocytosis, or elevated platelet counts, is increasingly recognized as a marker of bacterial infections. Platelets play an essential role in immune defense, facilitating bacterial clearance through mechanisms such as aggregation and cytokine release. Studies by **Singh et al. (2020)** and **Garg et al. (2019)** found that platelet counts exceeding 400,000/μL were associated with bacterial pathogens like **Haemophilus influenzae** and **Klebsiella pneumoniae**. Thrombocytosis is thought to arise from systemic inflammatory responses and cytokine-driven platelet production, particularly interleukin-6 (IL-6). Elevated platelet counts may also indicate complications such as septicaemia or disseminated intravascular coagulation (DIC), emphasizing the need for careful monitoring.While thrombocytosis is a valuable marker, it is essential to consider confounding factors such as chronic inflammatory states, iron deficiency anemia, or reactive thrombocytosis secondary to conditions like splenectomy or malignancies.

The presence of anemia in bacterial ARI adds another layer of complexity to clinical management. Anemia in this context is often multifactorial, resulting from systemic inflammation, iron sequestration (mediated by hepcidin), and reduced erythropoiesis. Studies by **Agarwal et al. (2020)** and **El-Galaly et al. (2019)** highlighted that hemoglobin levels below 10 g/dL were associated with worse clinical outcomes, including prolonged hospital stays and higher mortality rates.

Anemia exacerbates hypoxemia in ARI patients, particularly those with underlying pulmonary conditions. The correction of anemia through transfusion or erythropoietin-stimulating agents may improve oxygen delivery and mitigate respiratory distress. However, overcorrection carries risks, including volume overload and hypercoagulability, necessitating a balanced approach.

Streptococcus pneumoniae remains the leading bacterial cause of ARI globally. Haematological profiles in **S. pneumoniae** infections are characterized by significant neutrophilia and elevated NLR, reflecting the pathogen's ability to elicit robust innate immune responses. Studies by **Lippi et al. (2020)** and **Hussain et al. (2021)** confirmed these findings, with TLC values often exceeding 15,000 cells/μL and NLR thresholds above 3.0 serving as reliable indicators.**Staphylococcus aureus**, including methicillin-resistant strains (MRSA), is associated with more severe clinical presentations. These infections frequently result in elevated TLC, NLR, and platelet counts, indicating intense systemic inflammation. Studies by **Tiwari et al. (2021)** reported that MRSA pneumonia was associated with NLR values exceeding 4.0, suggesting that these markers may aid in identifying resistant pathogens and guiding early empirical therapy.

Infections caused by **Haemophilus influenzae** and **Klebsiella pneumoniae** are common in patients with underlying chronic conditions such as COPD. These pathogens are associated with pronounced haematological changes, including elevated platelet counts and neutrophilia. The findings of **Garg et al. (2019)** and **El-Galaly et al. (2019)** suggest that these markers not only aid in diagnosing bacterial etiology but also predict complications like pleural effusions and septic shock.

Clinical Implications

The integration of haematological parameters into routine clinical practice offers several advantages. These markers are widely available, cost-effective, and provide rapid results, making them invaluable

in resource-limited settings. They enable clinicians to stratify patients based on the likelihood of bacterial infections, prioritize antibiotic therapy, and monitor disease progression.
However, the interpretation of these markers requires caution. Conditions such as autoimmune diseases, hematological malignancies, and viral co-infections can confound the diagnostic utility of haematological parameters. Therefore, these markers should be used in conjunction with clinical findings, radiological assessments, and microbiological testing for a comprehensive evaluation.

Limitations and Future Directions
Despite their utility, haematological markers have limitations. Overlapping values in bacterial and viral infections, particularly during early disease stages, can lead to diagnostic uncertainty. Further research is needed to establish standardized thresholds for parameters like TLC, NLR, and platelet counts in diverse patient populations.
The development of combined diagnostic models incorporating haematological markers, inflammatory biomarkers (e.g., CRP, procalcitonin), and molecular diagnostics (e.g., multiplex PCR) could enhance accuracy. Additionally, studies exploring the prognostic value of these parameters in predicting long-term outcomes and guiding treatment strategies are warranted.

Conclusion and Summary
Acute respiratory illnesses (ARIs), particularly those caused by bacterial pathogens, represent a major health challenge globally, especially in tertiary care settings. The ability to rapidly and accurately distinguish bacterial ARIs from viral and other etiologies is crucial for optimizing patient management, reducing unnecessary antibiotic usage, and preventing complications such as sepsis and respiratory failure. Haematological parameters, including Total Leukocyte Count (TLC), Neutrophil-to-Lymphocyte Ratio (NLR), platelet count, and hemoglobin levels, offer practical and cost-effective tools for this purpose.

Conflicts of Interest
This is a UGSRS project financially supported by Dr.N.T.R University of Health Sciences.

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