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Differentiating Bacterial and Viral Lower Respiratory Tract Infections in Adults: The Diagnostic Value of Immature Granulocytes

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Abstract

Background

Lower respiratory tract infections (LRTI) are among the infectious diseases that cause the most deaths worldwide. Whether the etiology of LRTI is bacterial or viral will differentiate treatment options. Immature granulocyte (IG) values included in the complete blood count are a prominent biomarker in the diagnosis of infectious diseases or in determining their severity.

Objectives

This study aimed to investigate whether IGs can serve as an effective and novel biomarker for differentiating between bacterial and viral LRTIs.

Methods

Between January 2022 and December 2024, 491 patients diagnosed with pneumonia and treated at a tertiary care hospital, from whom respiratory tract samples were obtained, were included in the study. The patients' demographic characteristics, laboratory parameters such as CRP, procalcitonin (PCT), white blood cells (WBC), neutrophil-lymphocyte ratios (NLR), and IGs, blood culture results, and treatments received were recorded. Patients were divided into three groups based on the samples isolated from their respiratory tract: viral, bacterial, and viral+bacterial. Statistical analyses were performed using logistic regression and receiver operating characteristic (ROC) curves.

Results

Pathogens were detected in respiratory samples from 209 of 491 patients (42.6%). Viruses were the most frequently isolated pathogens (66%), followed by bacteria (26.9%) and co-infections (7.1-cov2%). When WBC, IG percentages, NLR, CRP, and PCT values were statistically analyzed for the presence of viral infection, it was found that IGs levels were approximately four times more likely to detect viral infection compared to other biomarkers. (LR = 3.897, 95% CI: 2.608–5.823, AUC = 0.686).

Conclusions

As an inexpensive, easily accessible, rapid, and practical marker, IGs can serve as a guide in differentiating between viral and bacterial lower respiratory tract infections.

Introduction

Lower respiratory tract infections (LRTIs) are among the most common infectious diseases and a leading cause of mortality worldwide [1, 2]. Globally, *S. pneumoniae* has been identified as the most frequent cause of pneumonia, accounting for 97.9 million cases. This is followed by Respiratory Syncytial Virus (RSV) with 46.4 million cases, other non-influenza viruses, and *Mycoplasma spp.* in third place with 25.3 million cases [3].

Viruses are known to cause approximately 40% of all LRTIs [1]. With the increased awareness brought about by the COVID-19 pandemic, there has been a noticeable rise in viral pneumonia diagnoses. While human rhinovirus and influenza viruses were previously the most common viruses in adults, the recent increase in the incidence of RSV infections in this population is particularly noteworthy [4, 5].

The etiology of LRTIs, whether viral or bacterial, significantly influences treatment approaches and duration. Differentiating viral from bacterial pneumonia often relies on molecular tests and inflammatory biomarkers. However, the accessibility and utilization patterns of molecular tests can vary due to availability and cost [2, 6]. Procalcitonin (PCT) and C-reactive protein (CRP) are well-known biomarkers frequently used for this distinction [4].

Neutrophils are leukocytes produced in the bone marrow and are the first and most dominant cells to reach infected tissues during a viral infection. The effectiveness of neutrophils has been studied as a biomarker for many viral and inflammatory conditions, both respiratory and non-respiratory [7, 8]. The precursors of neutrophils that can be used as biomarkers are immature granulocytes (IGs), which include metamyelocytes, myelocytes, and promyelocytes. Automated hematology analyzers use the method of fluorescent flow cytometry to examine the cellular membrane composition and cytoplasmic activity of white blood cell parameters. This allows neutrophils and lymphocytes to be classified more specifically based on the cellular activities caused by the inflammatory response to infection [9].

This study aims to investigate whether IGs, a component of routine complete blood count (CBC) tests, can serve as an effective and novel biomarker for differentiating between bacterial and viral LRTIs.

Materials and Methods

This retrospective study, conducted from January 2022 to December 2024 at a tertiary care hospital, included patients who were admitted with or received a diagnosis of pneumonia during their hospitalization. A total of 491 patients were enrolled in the study. All included patients were over 18 years of age, were monitored in either the Infectious Diseases or Anesthesiology and Reanimation Intensive Care Units (ICUs), and had a respiratory tract polymerase chain reaction (PCR) test performed. Patients with immunosuppressive or bone marrow suppressive therapy, pregnancy, malignancy, or autoimmune diseases were excluded.

Patient data were accessed through the hospital's electronic information system. C-reactive protein (CRP), procalcitonin (PCT), and complete blood count parameters, including white blood cell count, IGs percentages, and neutrophil-lymphocyte ratio (NLR), were recorded from the same day the respiratory

tract PCR sample was collected. Information on whether a blood culture was obtained within three days before and three days after the PCR sample was collected, and the results of the cultures if they were positive, were also recorded. Antimicrobial treatments administered at the time of respiratory sample collection were documented. Patients were divided into two groups based on their clinical setting: ward and ICU. Furthermore, patients were also categorized into three groups according to the isolated pathogen in their respiratory PCR samples: bacterial, viral, and a combination of bacterial and viral.

Samples from patients were placed in “NAT transfer tubes” containing transport medium and delivered to the microbiology laboratory. The samples were stored at -20°C until the time of PCR testing. They were evaluated using the Respiratory Tract RT-PPCR MX-24L panel kit (Bioeksen AR-GE Teknolojileri A.Ş., Türkiye) on the MIC system.

Statistical analysis was performed using IBM SPSS Statistics Version 21. The normality of quantitative variables was assessed using the Kolmogorov-Smirnov Test. Descriptive statistics for continuous variables were presented as mean ± standard deviation (SD) for normally distributed data, and as median and interquartile range (IQR) for non-normally distributed data. Categorical variables were presented as counts or percentages. For comparing categorical variables between independent groups, the Pearson Chi-square and Fisher's Exact tests were used. For continuous variables, the Student's t-test was used for normally distributed data, and the Mann-Whitney U test for non-normally distributed data. Logistic regression analysis was employed for multivariate analysis to identify factors associated with the dependent variable. Receiver Operating Characteristic (ROC) analysis was used to determine cut-off values. The discriminatory power of the model was evaluated by the area under the ROC curve (AUC), and the accuracy of the prediction performance was tested with a calibration curve. A p-value of < 0.05 was considered statistically significant.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was conducted retrospectively using de-identified medical records; therefore, active patient recruitment or formal informed consent was not required. Ethics committee approval for this study was obtained from the Ankara Training and Research Hospital Ethics Committee on August 21, 2024, under number E-24-136.

Results

A total of 491 patients who had a respiratory tract PCR sample submitted were included in the study. Of these, 250 (51%) were female and 241 (49%) were male, with a mean age of 66.97 (± 18.1) years. A significant majority of patients, 354 (72.1%), were monitored in the wards, while 137 (27.9%) were in the ICU. The mean age of patients in the ICU was significantly higher (71.13 ± 15.8) compared to ward patients (65.36 ± 18.6), a finding that was statistically significant ($p = 0.001$). Of the total patients, 209 (42.6%) had a bacterial, viral, or combined pathogen detected. Viruses were the most common pathogens isolated in 138 patients (66%), followed by bacteria in 56 patients (26.9%) and a combination

of bacteria and viruses in 15 patients (7.1%). The rate of co-detection of viral and bacterial pathogens was statistically higher in ward patients (80%) compared to ICU patients (20%) ($p = 0.004$).

Blood cultures taken within three days before and after the respiratory sample collection were examined. Blood cultures were not performed in 99 patients (20.2%), and no growth was found in 336 (87.9%) of the patients who did have cultures. Among ward patients, 260 (73.5%) blood cultures showed no growth, a rate significantly higher than in ICU patients ($p < 0.05$). Bacteremia was detected in only 31 (7.9%) of all patients. The most common bacteria isolated from ward patient blood cultures were coagulase-negative *Staphylococcus spp.* (45.1%), followed by *Staphylococcus aureus* (16.1%), *Klebsiella pneumoniae* (9.7%), *Enterococcus spp.* (6.45%), *Escherichia coli* (6.45%), and other bacteria (6.45%). For ICU patients, the isolates were coagulase-negative *Staphylococcus spp.* (41.7%), *Klebsiella pneumoniae* (29.1%), *Staphylococcus aureus* (8.3%), and other bacteria (20.8%). A bacterial pathogen was detected in the respiratory samples of 19 (5.8%) bacteremic patients, but this was not statistically significant ($p = 0.554$). When examining IGs values in bacteremic patients, no statistically significant relationship was found between the presence of bacteremia and IGs values ($p = 0.851$).

A total of 159 viral pathogens were identified in 140 patients. The most frequently detected pathogen was SARS-CoV-2 (26.4%), followed by Influenza A/B (24.5%). Other pathogens included RSV (10%), Enterovirus (10%), Parainfluenzavirus (7.5%), Rhinovirus (7.5%), seasonal Coronavirus (6.2%), Metapneumovirus (6.2%), and Adenovirus (1.8%). Among the 56 patients with a bacterial pathogen, 78 bacteria were isolated. The most common were *Streptococcus pneumoniae* (52.5%), *Haemophilus influenzae* (29.5%), *Klebsiella pneumoniae* (15.4%), *Bordetella pertussis* (1.3%), and *Mycoplasma spp.* (1.3%).

Regarding the treatments administered at the time of respiratory sample collection, 388 patients (79%) were receiving antibiotics, 34 (6.9%) a combination of antibiotics and antivirals, and only 6 (1.2%) were on antiviral therapy alone. Ward patients were significantly more likely to be started on a combination of antibiotics and antivirals (9.3% vs. 0.7%) compared to ICU patients ($p < 0.05$). Of the 40 patients with Influenza detected in their respiratory samples, 36 (90%) were diagnosed during the influenza season, but only 11 (27.5%) were receiving antiviral treatment at the time of sample collection ($p = 0.000$; LR, 9.125; 95% CI, 3.94–21.11).

An analysis of laboratory parameters—white blood cell count, IGs, NLR, CRP, and PCT—revealed that ICU patients had significantly higher white blood cell and NLR values compared to ward patients ($p = 0.001$, $p = 0.00$). Patient characteristics based on the unit they were monitored in are summarized in Table 1.

The seasonal and monthly distribution of pathogens identified by PCR was also examined. Respiratory PCR samples were most frequently submitted during the winter months (45.8%). The seasonal distribution of viral pathogen detection rates was as follows: winter (36.6%), spring (29.6%), autumn (25.3%), and summer (15.5%). This relationship between seasons and viral pathogen detection was not statistically significant ($p = 0.107$). Similarly, no statistical significance was found between the months and the viral detection rates ($p = 0.114$).

The IGs percentages of patients were examined according to whether the causative agent was identified or not. The median IGs in the group where the causative agent was not identified was 0.06 (IQR: 0.50), while it was 1.00 (IQR: 1.75) in the group where the causative agent was identified. This difference was found to be statistically significant (p = 0.00).

Patients were also grouped according to the pathogen isolated from their respiratory samples: Group 1 (bacterial), Group 2 (viral), and Group 3 (bacterial and viral co-infection). No statistically significant differences were found in age and sex distribution across the three groups (p = 0.275, p = 0.887) (Table 2).

The laboratory parameters—white blood cell count, IGs, NLR, CRP, and PCT—were evaluated as potential markers for diagnosing viral LRTIs. No statistically significant differences were observed between the groups for white blood cell count, NLR, CRP, and PCT (p = 0.735, p = 0.918, p = 0.059, p = 0.550). However, the distribution of immature granulocyte percentages was found to be statistically significant in distinguishing viral from bacterial pathogens (p = 0.000). A cut-off value of 0.95 for IGs was determined using the ROC curve (Fig. 1). A subsequent regression analysis revealed that an IGs percentage greater than 0.95 increased the probability of a viral pathogen being detected by approximately fourfold, a finding that was statistically significant (p = 0.000; LR, 3.897; 95% CI, 2.608–5.823, AUC: 0.686, PPD: 59%, NPD: 74%) (Table 2, Fig. 1).

The three most common viral pathogens found in the study were SARS-CoV-2, Influenza A/B, and RSV. The relationship between these pathogens and IGs percentages was assessed. An IGs percentage > 0.9 was found to be statistically significant in the presence of Influenza and SARS-CoV-2 infections (for Influenza: p = 0.000; LR, 4.339; 95% CI, 2.142–9.035, AUC: 0.715, PPD: 70%, NPD: 68%; for SARS-CoV-2: p = 0.005; LR, 2.556; 95% CI, 1.305–5.007, AUC: 0.627, PPD: 56%, NPD: 67%) (Table 3, Fig. 2). No statistically significant relationship was found between IGs percentage and RSV (p = 0.064), which we attribute to the limited number of RSV cases (10%) in our study.

Discussion

While antiviral immunity has historically been associated with adaptive immune responses, evidence now highlights the critical role played by the cells of the innate immune system in the host response to viruses. The antiviral capabilities of neutrophils are extensive and include the phagocytosis of virus-infected cells, the release of neutrophil extracellular traps, the secretion of reactive oxygen species, cytotoxic granules, and inflammatory molecules that limit viral infection and spread while initiating adaptive antiviral processes [10].

Single-cell sequencing of neutrophils during human health and disease has shown that they possess significant plasticity. Transcriptomic differences are observed not only with different stressors but also change over time in response to stress. The neutrophil transcriptome also varies between more severe and less severe disease states, though it has not yet been determined whether this reflects the neutrophils' own role in disease severity or a suppressed response that leads to severity [11]. In this

context, studies in the literature have shown a relationship between IGs and the severity of COVID-19 infection [8, 12]. In their study, Georgakopoulou et al. demonstrated a positive correlation between IGs and both intubation and mortality [8]. A study examining neutrophil-endothelial interaction in RSV-related bronchiolitis noted that blood levels of mature and immature neutrophils were increased in RSV bronchitis, concluding that further research is needed on this topic [13].

Following the COVID-19 pandemic, non-medical interventions such as masks and movement restrictions have been reported to decrease the frequency of viral LRTIs caused by Influenza and RSV. This is also influenced by the increasing vaccination rates against RSV and other respiratory pathogens in both pediatric and adult populations [3]. However, due to ongoing diagnostic challenges, it is still not always easy to differentiate between viral and bacterial LRTIs.

In this study, we aimed to test whether IGs could be a practical and low-cost biomarker for diagnosing viral LRTIs. We found that IGs levels were statistically significantly higher in patients with a viral pathogen detected in their respiratory PCR samples compared to those with a bacterial pathogen or no pathogen isolated ($p = 0.000$; LR, 3.897; 95% CI, 2.608–5.823). In contrast, other potential biomarkers for this differentiation, such as NLR, CRP, and PCT, showed no statistical significance ($p = 0.735$, $p = 0.918$, $p = 0.059$, $p = 0.550$).

The diagnostic power of PCT, a frequently used biomarker for distinguishing between viral and bacterial infections, was evaluated by Siljan et al. in a study on community-acquired pneumonia. They suggested that when low PCT values are used in conjunction with molecular methods, the host's viral genetic signature could guide the discontinuation of antimicrobial therapy, but they did not demonstrate PCT's standalone diagnostic power [14]. In a study by Self et al., 1735 patients, 24% of whom were diagnosed with viral LRTIs, were examined. They found that there was no ideal threshold value for PCT in differentiating viral from bacterial pathogens, although typical bacterial pneumonia pathogens showed a positive correlation with PCT. However, they noted that there was no such correlation for atypical and viral pathogens, suggesting that atypical pathogens show a similar trend to viral ones [15].

The IGs value obtained from a routine CBC is a rapid and inexpensive parameter [16]. Many studies have shown that this easily accessible marker is effective in determining the severity of COVID-19 [8, 16–18]. However, a review of the literature reveals a lack of sufficient studies on its diagnostic value in differentiating between bacterial and viral LRTIs. In our study, we found that an IGs percentage above 0.95 increased the likelihood of a viral pathogen detection by fourfold (AUC: 0.686, PPD: 59%, NPD: 74%). This finding was not associated with disease severity, as no difference was found when evaluating patients in the wards and the ICU separately or together.

In a study comparing infected and healthy children, IGs were incorporated into a scoring system along with other parameters like Neutrophil Reactive Intensity (Neut-RI) and Delta-He. This score demonstrated high discriminatory power (AUC 0.99) for diagnosing infection, but data on its ability to distinguish between bacterial and viral infections was not provided [19]. Meriyanti et al. examined the role of extended white blood cell parameters in distinguishing the etiology (bacterial or viral) of febrile illnesses.

Unlike our study, they investigated Dengue and Chikungunya viruses rather than respiratory viruses. They concluded that when used together, IGs and other extended white blood cell parameters could differentiate bacterial infections from other acute febrile illnesses [9].

The most commonly isolated viral pathogens in our study were Influenza and SARS-CoV-2. We found that with a cutoff value of 0.95, the likelihood of influenza diagnosis increased approximately fourfold, while the likelihood of COVID-19 diagnosis increased 2.5-fold (for influenza: AUC: 0.715, PPD: 70%, NPD: 68%; for COVID-19: AUC: 0.627, PPD: 56%, NPD: 67%). While no significant relationship was found between IGs percentage and RSV, we believe this is due to the small number of RSV cases (10%) in our study.

A study by Kim et al. investigated the utility of the delta neutrophil index (DNI), which includes IGs, in distinguishing between bacterial infections without bacteremia and viral infections in febrile children. They found that DNI did not contribute to the differentiation between bacterial and viral infections in the absence of bacteremia [20]. In our study, blood culture was performed in 79.8% of patients, and growth was detected in 31 (7.9%) of those. However, no statistically significant relationship was found between the presence of bacteremia and IGs values ($p = 0.851$).

In clinical practice, it is common to empirically initiate antiviral therapy or to continue antibacterial therapy when a viral etiology cannot be ruled out in patients with a diagnosis of LRTI. Community-acquired pneumonia is one of the most common diagnoses for antibiotic prescriptions worldwide [21]. The presence of severe infection with an unknown etiology limits the ability to withhold antibiotics [22, 23]. In a study by Alonso et al., it was found that despite being supported by molecular tests, treatment was adjusted in only 33.7% of patients [2]. Furthermore, combining broad-spectrum bacterial and viral mPCR with biomarkers has limitations, including availability, turnaround time, and cost [24]. In our study, 388 patients (79%) were receiving antibiotic treatment. Despite being diagnosed during the influenza season, only 11 (27.5%) of the patients with an influenza diagnosis were receiving antiviral therapy at the time the sample was submitted. One limitation of our study is that treatment revisions after PCR sample results were not examined.

Our study has several limitations. First, there was no significant difference in IGs percentage values when ward and ICU patients were evaluated separately or collectively. However, the presence of sepsis, especially in ICU patients, was not ruled out, and patients were not classified by clinical severity using pneumonia scoring systems or evaluated for clinical severity levels. Another limitation is that the vaccination status of patients included in the study for LRTIs was not questioned. This could have been particularly useful for examining the distribution of isolated viral pathogens and related clinical findings. Another missing piece in this study was the lack of examination of whether treatment changes were made after the results of respiratory samples were available. This study only examined patients with a diagnosis of LRTI. Future studies comparing patients with LRTI to those with viral upper respiratory tract infections could more effectively evaluate the diagnostic power of IGs in virus-related LRTIs.

Conclusion

As an inexpensive, easily accessible, rapid, and practical marker, IGs can serve as a guide in differentiating between viral and bacterial lower respiratory tract infections. We believe that the results of this study, when considered alongside its limitations, will provide insight for future research in larger patient populations, ultimately guiding antibiotic stewardship and the empirical initiation of antiviral therapy.

Abbreviations

AUC
Area Under the Curve
CBC
Complete Blood Count
CI
Confidence Interval
CRP
C-Reactive Protein
ICU
Intensive Care Unit
IGs
Immature Granulocytes
LR
Likelihood Ratio
LRTI
Lower Respiratory Tract Infection
NLR
Neutrophil-to-Lymphocyte Ratio
NPD
Negative Predictive Value
PCR
Polymerase Chain Reaction
PCT
Procalcitonin
PPD
Positive Predictive Value
ROC
Receiver Operating Characteristic
RSV
Respiratory Syncytial Virus
SARS-CoV-2

Severe Acute Respiratory Syndrome Coronavirus 2
SD
Standard Deviation
WBC
White Blood Cell

Declarations

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethics committee approval for this study was obtained from the Ankara Training and Research Hospital Ethics Committee on August 21, 2024, under number E-24-136.

Consent for publication

Not applicable.

Competing Interests

The authors declare that they have no competing interests.

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Author Contribution

E.K.K., S.C. and Ş.A.D. designed the project. Ş.B.E., S.Ü. and A.E.K. collected and organized the data. Ç.A.H. ,G.T.E. and S.K. conducted statistical analyses. B.Ş. and Ç.K. created figures and tables. E.K.K., S.C. and Ş.A.D. wrote the main manuscript text. All authors reviewed the manuscript.

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None.

Data Availability

The dataset for this study can be accessed via the following link: https://docs.google.com/spreadsheets/d/e/2PACX-1vSJhTYiYcTBqcEHdg7lxlN0hocAqB7dfKaPeoyI0fSQcU1TyByaXjsdyi3GfKXR7w/pubhtml

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Tables

Table 1 : Clinical and Laboratory Comparison of ICU and Ward Patients

*** Based on a total of 209 detected factors**

(WBC: White blood cell count, **IGs:** İmmatur garanülosit **, NLR:** Neutrophil-Lymphocyte Ratio**, CRP:** C-reactive protein **, PCT:** Procalcitonin**)**

(Continuous variables were given as mean ± standard deviation if they were normally distributed, and as median and interquartile range (IQR) if they were not normally distributed. Categorical variables were given as numbers and percentages.)

	Total (n=491)	Service (n=354)	ICU (n=137)	p-value
Gender F/M	250 (%51)/241 (%59)	173 (%49)/181 (%51)	77 (%56)/60 (%44)	0.145
Age	66.97 (±18.1)	65.36 (±18.6)	71.13(±15.8)	**0.001**
Agent detection status (detected/not detected)	209 (%42.6)/282 (%57.4)	165 (%46.6)/189 (%53.4)	44 (%32.1)/93 (%67.9)	**0.004**
Bacteria*	56 (%26.9)	45 (%80.3)	11 (%19.7)	
Virus*	138 (%66)	108 (%78.2)	30 (%21.8)	
Bacteria+Virus*	15 (%7.1)	12 (%80)	3 (%20)	
Blood culture				**0.027**
Not taken	99 (%20.2)	63 (%17.9)	37 (%27.6)	
No growth	336 (%87.9)	259 (%73.3)	73 (%54.5)	
Growth present	46 (%12.1)	31 (%8.8)	24 (%17.9)	
Treatment				**0.005**
Antibiotic	388 (%79)	280 (%79.1)	108 (%78.8)	
Antiviral	6 (51.2)	5 (1.4)	1 (0.7)	
Antibiotic+Antiviral	34 (%6.9)	33 (%9.3)	1 (%0.7)	
Laboratory parameters				
WBC(L)	10883.9 (±5878.2)	10361.1 (±5531.9)	12234 (±3520.2)	**0,001**
IGs (%)	0.7 (min-max: 0-14.5, IQR:1)	0.7 (min-max: 0-14.5 IQR:1)	0.8 (min-max: 0-9 IQR:1.2)	0.277
NLR	9.1 (±9.52)	7.5 (±7.14)	13.55 (±12.95)	**0.000**
CRP (mg/L)	117.09 (±95.59)	116.92 (±96.58)	117.54 (±93.38)	0.949
PCT (µ/L)	0.33 (min-max:0-123.1, IQR: 1.25)	0.25 (min-max:0-123.1, IQR:0.92)	0.56 (min-max:0-100, IQR:1.76)	0.933

Table 2 : Distribution of Patients According to the Isolated Agents

(WBC: White blood cell count, **IGs:** İmmatur garanülosit **, NLR:** Neutrophil-Lymphocyte Ratio**, CRP:** C-reactive protein **, PCT:** Procalcitonin**)**

(Continuous variables were given as mean ± standard deviation if they were normally distributed, and as median and interquartile range (IQR) if they were not normally distributed. Categorical variables were

given as numbers and percentages.)

	Group 1 (n=56)	Group 2 (n=138)	Group 3 (n=15)	p-value	Odds ratio	95%CI	p-value
Gender F/M	22(%39.3)/34 (%60.7)	69 (%50)/69 (%50)	8(%53.3)/7 (%46.7)	0.275			
Age	68 (±17.6)	66.5 (±18.0)	69.8 (±18.6)	0.887			
Laboratory parameters							
WBC **(L)**	11275.3 (±5231.1)	10544.5 (±6667.1)	9910.0 (±3419.09)	0.735			
IGs (%)	0.94 (±0.88)	2.06 (±2.32)	1.4 (min-max: 0.3-9.20, (IQR: 3.98)	**0.000**	**3.897**	**2.608-5.823**	**0.00**
NLR	9.9 (±8.49)	6.9 (min-max:0.4-92.5, IQR: 7.20)	6.5 (min-max:1.7-29.2, IQR: 7.30)	0.918			
CRP (mg/L)	129.59 (±98.53)	99.49 (±88.19)	98.07 (±63.60)	0.059			
PCT (µ/L)	0.34 (min-max:0-40.7, IQR: 2.60	0.34 (min-max:0.003-100, IQR:2.60)	0.45 (min-max:0.5-15.73, IQR: 0.79)	0.550			
Bacteremia							
present/absent	1 (%1.8)/55 (%98.2)	8 (%5.8)/130 (%94.2)	0/15 (%100)	0.255			

Table 3: Immature Granulocyte Percentages According to the Most Frequently Isolated Viral Agents

	IGs	p value	Odds ratio	95%CI
Influenza	1.6 (min-max:0-14.5)	**0.000**	4.339	2.142-9.035
SARS-CoV-2	1.1 (min-max:0.2-10.2)	**0.005**	2.556	1.305-5.007
RSV	1.6 (min-max:0.2-6.5)	0.064	2.743	0.905-8.310

Figures

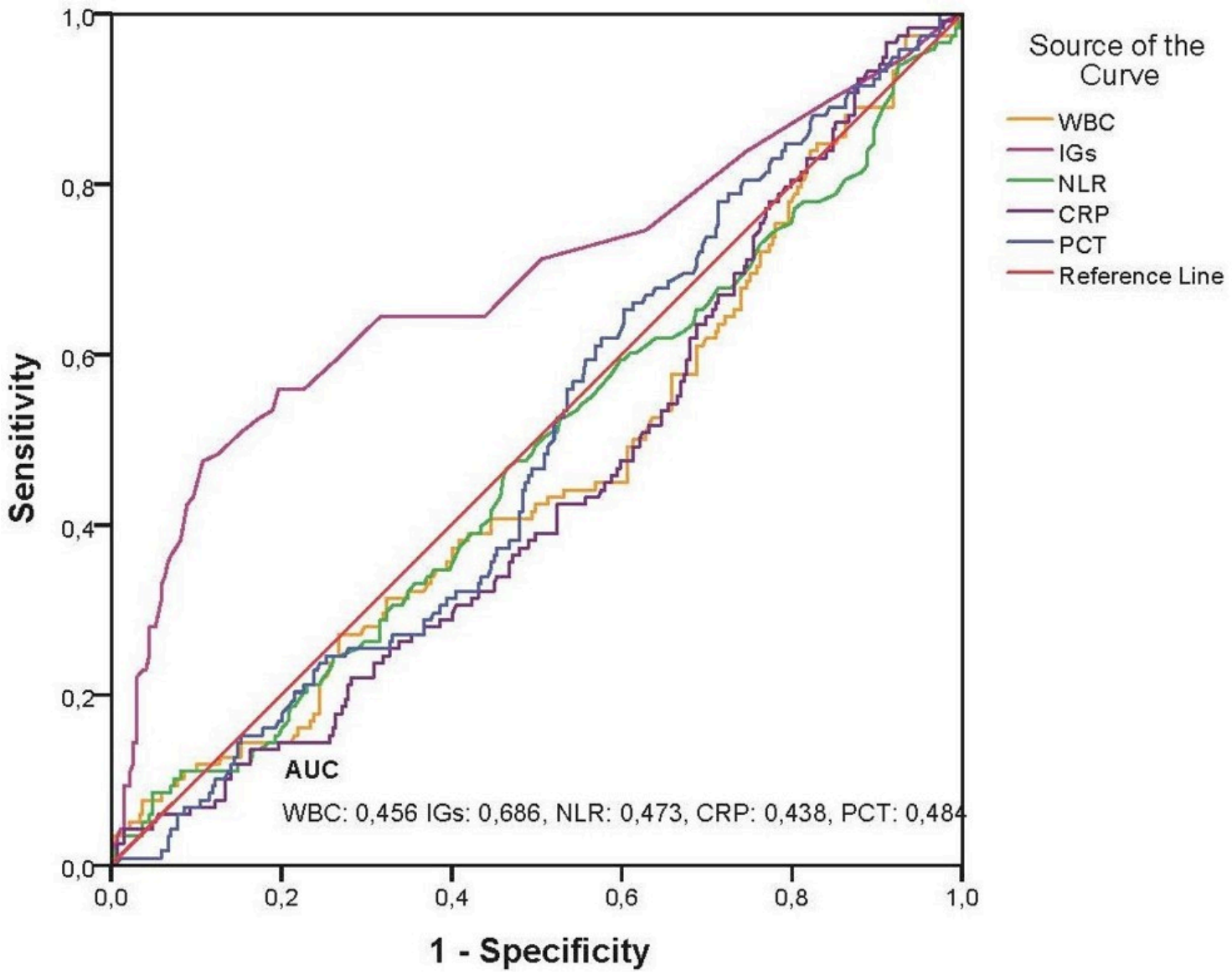
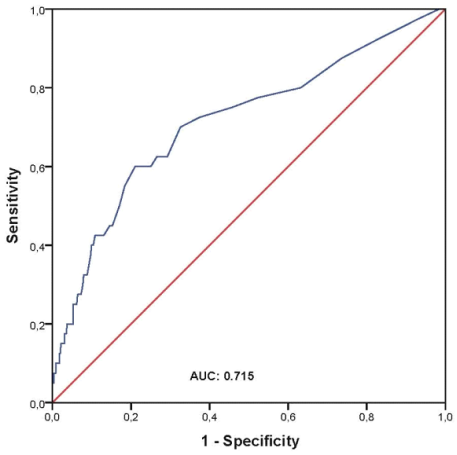
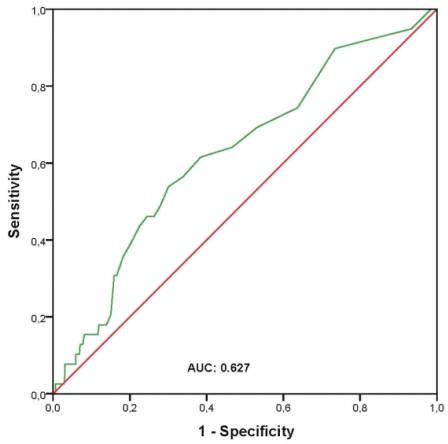


Figure 1

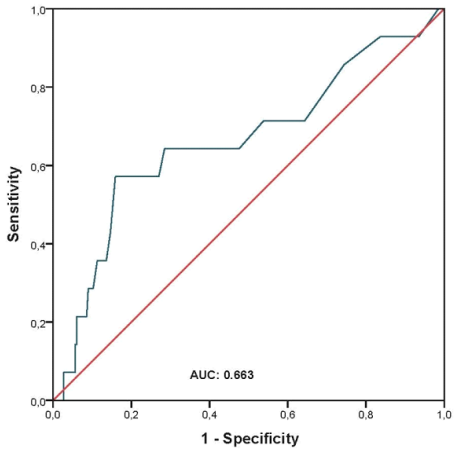
ROC Curve Regarding the Predictive Power of Laboratory Parameters for the Etiology of Lower Respiratory Tract Infections



A



B



C

Figure 2

A: ROC Curve for the Predictive Power of Immature Granulocyte Percentage for **Influenza Vırus**

B: ROC Curve for the Predictive Power of Immature Granulocyte Percentage for **SARSCoV-2**

C: ROC Curve for the Predictive Power of Immature Granulocyte Percentage for **RSV**