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Volume: 20 Issue: 2 Year: 2025 Original Article e-ISSN: 1305-7707

# Comparison of Ischemia-Modified Albumin Levels in Children with Pneumonia and Bronchiolitis

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**Article Info**

**Received:** Jan 30, 2024
**Accepted:** Jan 13, 2025
**Published:** May 27, 2025

**Keywords:**
Ischemia-modified albumin,
pneumonia,
bronchiolitis,
biomarkers.

**ABSTRACT**

**Objectives:** Bronchiolitis and bronchopneumonia are important causes of hospitalization in children. Many biomarkers are used in monitoring the clinical course of these diseases, grading severity, and making hospitalization decisions. This study is therefore intended to evaluate the role of ischemia-modified albumin (IMA) level in the differential diagnosis of pneumonia and bronchiolitis and to compare it with other biomarkers used in the diagnosis.

**Methods:** Thirty patients with pneumonia and thirty patients with bronchiolitis were included in our study. Patients were diagnosed based on history, physical examination, posteroanterior chest radiography, as well as serum C-reactive protein (CRP), sedimentation, procalcitonin (PCT), hemogram, and serum IMA levels.

**Results:** In our study, the group of patients with pneumonia had higher levels of CRP, PCT, and serum IMA. CRP ($p = 0.001$), IMA ($p = 0.009$), and PCT ($p = 0.101$) had the highest levels of sensitivity and specificity in the group of patients with pneumonia, respectively. In patients with pneumonia, IMA is more sensitive and specific than PCT.

**Conclusion:** In this study examining pneumonia and bronchiolitis, IMA levels have shown to be an important parameter in making the decision of differential diagnosis between pneumonia and bronchiolitis compared with other biomarkers used in the diagnosis. Given that IMA is similar to other biomarkers cost-wise, IMA may be a more utile parameter in the future.

**To cite this article:**

Capan Gün, E., Husrevoğlu Esen, F., Cag, Y., & Akın, Y. (2025). Comparison of ischemia-modified albumin levels in children with pneumonia and bronchiolitis. *Journal of Pediatric Infectious Diseases, 20*(2), 139-147.

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## Introduction

Pneumonia is an acute inflammation that occurs in the lung tissue mostly due to infectious causes such as viruses and bacteria, or less frequently due to non-infectious causes.[1] Pneumonia presents with a clinical picture of fever, respiratory symptoms, and parenchymal involvement in the lungs proven by physical examination and/or presence of infiltration on chest radiography.[2] According to the World Health Organization data, 155 million children aged five years and younger are diagnosed with pneumonia every year.[3] In Turkey, according to the results of the Study of Disease Burden in Turkey, respiratory tract infections are the second most common cause of death, representing the 13.4% in the 0–4 age range and the 6.5% in the 5–14 age range, for a total of 14% of all deaths in the 0–14 age range.[4]

Patient history, physical examination, and radiologic evaluation are important for the diagnosis of pneumonia. The aim of clinical evaluation is to define the clinical picture, estimate the etiologic agent, and grade the severity of the disease.[5]

While white blood cell count (WBC) and absolute neutrophil count, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) and procalcitonin (PCT) values can be used in the differential diagnosis between viral and bacterial pneumonia, in deciding whether to administer antibiotic treatment and in selecting the antibiotic therapy to be administered, their sensitivity, specificity, and positive predictive values remain variable.[6]

Bronchiolitis is a common, acute infectious disease of the lower respiratory tract in infants and children, resulting in the obstruction of the small airways. It is the most significant respiratory disease in children. Respiratory syncytial virus is responsible for 50%–90% of the cases.[7] Bronchiolitis leads to necrosis of the epithelium of the bronchioles due to the virus, increased mucus secretion,cell infiltration, and edema in the submucosa. As a result, collapse or hyperinflation develops in the distal lung tissue.[8]

Listed among the recently investigated cardiac markers, ischemia-modified albumin (IMA) has been approved by the U.S. Food and Drug Administration as a test.[9] The test functions principally based on the fact that oxidative free radicals formed during ischemia, hypoxia, and acidosis lead to chemical changes in albumin and decrease its cobalt binding capacity. This new albumin molecule is also called IMA and is measured spectrophotometrically by the albumin cobalt binding test.[10] The formation of this new albumin molecule that has lost its ability to bind cobalt is one of the earliest markers of ischemia [11]. Recent studies show that IMA, which stands out as a marker of cardiac ischemia, may also increase in different pathologies.[12,13,14] IMA occurs due to high oxidative stress not only in myocardial ischemia but also in different ischemia models affecting other organs[15]. Serum IMA level increases in diseases with non-cardiac ischemia, pulmonary embolism, cardiopulmonary resuscitation, end-stage renal disease, cerebrovascular ischemia, acute mesenteric ischemia, systemic sclerosis, arthroscopic knee surgery, skeletal muscle ischemia after exercise, diabetes mellitus, liver diseases, some cancers, infection, and peripheral vascular diseases.[15,16]

There is a study in the literature showing that IMA, an oxidative stress marker, is associated with transient tachypnea of the newborn (TTN), but there is no comprehensive study on its relationship with pneumonia and bronchiolitis.[19] Therefore, this study is intended to investigate the role of IMA level, which occurs in cases of ischemia and has been used as a novel marker of ischemia recently, in differential diagnosis between pneumonia and bronchiolitis and to compare its value with other biomarkers used in the diagnosis.

## Materials and Methods

This study was conducted in the Pediatric Emergency Clinic of Kartal Lütfi Kırdar City Hospital between December 2021 and June 2022. Ethical approval was obtained for this prospective case-control study with the Clinical Research Ethics Committee of Kartal Lütfi Kırdar City Hospital Decision No. 2021/s14/214/1 of 30th November, 2021. The study was conducted in accordance with the ethical rules of the Declaration of Helsinki.

In our study, out of patients aged younger than 18 who were admitted to the Pediatric Emergency Department of Kartal Lütfi Kırdar City Hospital, 30 patients diagnosed with pneumonia, 30 other patients diagnosed with bronchiolitis, and 30 healthy control subjects selected on the evaluation of their physical examination and their radiological and laboratory findings together were included in the patient groups. Six patients diagnosed with bronchiolitis were not hospitalized.

**Table 1.** Comparison of variables in the study groups

| | Groups | | | Test statistics | | Post hoc comparisons | | |
|---|---|---|---|---|---|---|---|---|
| | Pneumonia *n*=30 | Bronchiolitis *n*=30 | Control *n*=30 | Test value | *p* value | Pneumonia *Vs* Bronchiolitis | Pneumonia *Vs* *Control* | Bronchiolitis *Vs* *Control* |
| **Gender**, *n* (%) | | | | | | | | |
| female | 15 (50.0) | 10 (33.3) | 15 (50.0) | 2.250 | 0.369[†] | | | |
| male | 15 (50.0) | 20 (66.7) | 15 (50.0) | | | | | |
| **Age**, (*month*) | 26.5 (8.0-107.0) | 18.0 (4.0-119.0) | 30.0 (12.0-115.0) | 4.580 | 0.101[‡] | | | |
| **INF** | | | | | | | | |
| no | 0 (0.0) | 30 (100.0) | 30 (100.0) | 103.361 | **<0.001**[†] | | | |
| yes | 30 (100.0) | 0 (0.0) | 0 (0.0) | | | | | |
| **Hospitalization**, *n* (%) | | | | | | | | |
| no | 0 (0.0) | 6 (20.0) | 30 (100.0) | 83.112 | **<0.001**[†] | | | |
| yes | 30 (100.0)[a] | 24 (80.0)[b] | 0 (0.0)[c] | | | | | |
| **Hospitalization time** (day) | 6.0 (2.0-15.0) | 6.5 (4.0-11.0) | - | 0.079 | 0.937 | | | |
| **CRP** (mg/L) | 17.00 (74.83)[a] | 5.25 (11.60)[b] | 0.53 (1.24)[c] | 43.129 | **<0.001**[‡] | **0,046** | **<0,001** | **<0,001** |
| **Sedim** (mm/h) | 8.0 (10.5)[a] | 5.5 (4.0)[ab] | 5.0 (2.5)[b] | 6.289 | **0.043**[‡] | **0,165** | **0,042** | **0,999** |
| **Procalcitonin** (mcg/L) | 0.134 (2.510)[a] | 0.101 (0.110)[a] | 0.035 (0.030)[b] | 42.913 | **<0.001**[‡] | **0,186** | **<0,001** | **<0,001** |
| **IMA** **(ng/ml)** | 412.4 (485.7)[a] | 181.4 (201.4)[b] | 207.0 (498.6)[ab] | 6.662 | **0.036**[‡] | **0,033** | **0,999** | **0,286** |
| **WBC** (mcL) | 14.18 (4.75)[a] | 10.54 (4.14)[b] | 7.15 (2.02)[c] | 39.091 | **<0.001**[‡] | **0,040** | **<0,001** | **0,001** |
| **Neutrophil** (mcL) | 9.00 (7.92)[a] | 4.63 (4.10)[b] | 3.56 (1.54)[b] | 18.428 | **<0.001**[‡] | **0,019** | **<0,001** | **0,393** |
| **Lymphocyte** (mcL) | 3.44 (2.75)[ab] | 3.87 (2.99)[a] | 2.75 (1.06)[b] | 9.148 | **0.010**[‡] | **0,999** | **0,123** | **0,009** |
| **N/L** | 2.65 (3.07)[a] | 1.15 (2.23)[b] | 1.31 (0.90)[ab] | 7.398 | **0.025**[‡] | **0,039** | **0,084** | **0,999** |
| **PLT** (mcL) | 394.0 (176.7)[a] | 320.5 (129.2)[b] | 367.5 (133.2)[ab] | 7.078 | **0.029**[‡] | **0,024** | **0,377** | **0,775** |
| **pH** | 7.37 (0.06) | 7.35 (0.05) | - | 1.150 | 0.250[&] | | | |
| **CO2** | 37.15 (5.33) | 37.20 (8.10) | - | 0.776 | 0.438[&] | | | |
| **O2** | 50.35 (38.98) | 50.10 (24.00) | - | 0.379 | 0.705[&] | | | |
| **Lactic acid** | 2.15 (1.08) | 1.50 (0.60) | - | 3.073 | **0.002**[&] | | | |

Patients older than 18 years, patients with chronic diseases that increase the frequency of pneumonia (cystic fibrosis, asthma, bronchopulmonary dysplasia, tuberculosis, etc.), congenital heart disease, neuromuscular disease, immunodeficiency, hematologic disease, or patients who refused to participate in the study were excluded.

Moderate to severe cases of bronchiolitis and pneumonia requiring hospitalization were included in the current study. A scoring system that considers the respiratory rate per minute, wheezing, retractions, and general condition was used to assess disease severity.[17] The examination also considered skin color and hydration status.

According to this scoring system, the following severity assessment was applied:

1. Mild illness: 1–3 points
2. Moderate illness: 4–8 points
3. Severe illness: 9–12 points

Disease severity assessment decided according to;

IMA (Ischemia-Modified Albumin) levels are measured using the albumin-cobalt binding test.[20] In our study, blood samples from patients were collected in 3 cc biochemistry tubes. The blood samples were centrifuged at 6000 revolutions per minute for 5 minutes to separate the serum, which was then stored at −80°C. After thawing, spectrometric measurements were performed at a wavelength of 450 nm using a Heales 580 device. To perform this measurement, a protein reagent called Dithiothreitol (DTT) is added, which reacts with free cobalt and causes a color change. DTT cannot react with cobalt bound to albumin. The amount of unbound free cobalt in the medium reflects the IMA value.[21] The obtained values represent optical density; a calibration curve was drawn based on these values, and calculations were performed according to the graphical equation.

The obtained data were analyzed using IBM SPSS Statistics Standard Concurrent User V 26 (IBM Corp., Armonk, New York, USA) and MedCalc® Statistical Software version 19.6 (MedCalc Software Ltd, Ostend, Belgium). Descriptive statistics were given as the number of units (n), percentage (%), median, minimum, maximum, and interquartile range values. The normal distribution of the data of numerical variables was evaluated using Shapiro–Wilk normality test. Since the numerical variables were not normally distributed, Kruskal–Wallis test was used for intergroup comparisons of the pneumonia bacterial, bronchiolitis viral infection, and control groups. Dunn–Bonferroni test was used as a post hoc test. Since pH, CO2, O2, and lactic acid data were not available in the control group, comparisons of these variables between the groups of pneumonia bacterial and bronchiolitis viral infection were performed with Mann–Whitney U test. Chi-square tests were used to compare categorical variables between the groups. The performances of biomarkers found to be significant in univariate analyses were evaluated using receiver operating characteristic (ROC) curve analyses. $p<0.05$ was considered statistically significant.

## Results

The study included 90 patients divided into three groups: 30 in the pneumonia group, 30 in the bronchiolitis group, and 30 healthy subjects in the control group **(Table 1).** The gender distribution was as follows: in the pneumonia group, there were 15 females (50.0%) and 15 males (50.0%); in the bronchiolitis group, there were 10 females (33.3%) and 20 males (66.7%); and in the control group, there

**Table 2.** Receiver operating characteristic (ROC) curve analysis results for ischemia-modified albumin (IMA), white blood cell count (WBC), C-reactive protein (CRP), procalcitonin, neutrophil/lymphocyte (N/L), mean platelet volume/platelet (PLT) and lactic acid (pneumonia versus bronchiolitis)

| | *AUC* (95 *CI* for *AUC*) | *p* | *Cutoff point* | *Sensitivty* (95 *CI* for *Sensitivty*) | *Specificity* (95 *CI* for *Specificity*) |
|---|---|---|---|---|---|
| IMA | 0.682 (0.548-0.797) | 0.009 | >330.5 | 53.3 (34.3-71.7) | 82.7 (64.2-94.2) |
| CRP | 0.714 (0.583-0.824) | 0.001 | >15.7 | 50.0 (31.3-68.7) | 90.0 (73.5-97.9) |
| Procalsitonin | 0.678 (0.545-0.793) | 0.101 | >0.773 | 36.6 (19.9-56.1) | 96.6 (82.8-99.9) |
| WBC | 0.737 (0.608-0.842) | <0.001 | >12.63 | 70.0 (50.6-85.3) | 76.6 (57.7-90.1) |
| N/L | 0.656 (0.522-0.774) | 0.030 | >2.01 | 63.3 (43.9-80.1) | 73.3 (54.1-87.7) |
| PLT | 0.697 (0.563-0.810) | 0.005 | >292 | 93.3 (77.9-99.2) | 48.2 (29.4-67.5) |
| Laktik Asit | 0.752 (0.611-0.862) | 0.001 | >1.9 | 64.3 (44.1-84.1) | 82.6 (61.2-95.0) |

*AUC*: Area under the curve, *CI*: Confidence Interval were 15 females (50.0%) and 15 males (50.0%). There was no statistical difference between the groups in terms of gender distribution. The ages of the patients ranged between 4 and 119 months, with no statistically significant difference between the groups in terms of age.

Infiltration (INF) was present in all of the pneumonia patients and absent in both the bronchiolitis and control groups. All patients with pneumonia were hospitalized, while six patients diagnosed with bronchiolitis were not hospitalized. None of the healthy control subjects required hospitalization. There was no statistical difference between the pneumonia and bronchiolitis groups in terms of length of hospital stay.

C-reactive protein (CRP) values were statistically significantly higher in the pneumonia group compared to the bronchiolitis and control groups. The differences in sedimentation rate (SEDIM) values between the groups were not statistically significant. Procalcitonin (PCT) values in the pneumonia and bronchiolitis groups were not significantly different but were significantly higher compared to the control group. IMA values in the pneumonia group were statistically higher than those in the bronchiolitis group.

The highest WBC value belonged to the pneumonia group, while the lowest WBC value to the control group. The neutrophil values in the pneumonia group were statistically higher than those in the bronchiolitis and control groups. The lymphocyte values in the bronchiolitis group were statistically higher compared to the control group. The lymphocyte values in the pneumonia group were statistically similar to those in the other two groups. The N/L ratio in the pneumonia group was statistically higher than that in the bronchiolitis group. The N/L ratio in the control group was statistically similar to those in the other two groups. The PLT value in the pneumonia group was statistically higher than that in the bronchiolitis group. The PLT value in the control group was similar to those in the other two groups. The pH, CO2, and O2 values in the pneumonia and bronchiolitis groups were similar. The lactic acid value in the pneumonia group was statistically higher than that in the bronchiolitis group.

The ROC curve analyses were performed to assess the diagnostic utility of various biomarkers in differentiating between pneumonia, bronchiolitis, and control groups. The results are summarized in **Tables 2, 3, and 4. In Table 2**, the ROC curve analysis for the pneumonia and bronchiolitis groups revealed that white blood cell count (WBC) exhibited the highest area under the curve (AUC) value of 0.737 (95% CI: 0.608-0.842, $p < 0.001$) **(Figure 1).**

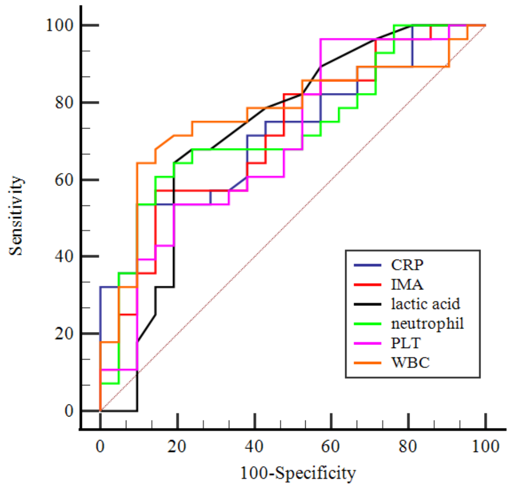


**Figure 1.** Performances of lactic acid, mean platelet volume/platelet (PLT), white blood cell count (WBC), C-reactive protein (CRP), neutrophil, and ischemia-modified albumin (IMA) variables in predicting pneumonia (pneumonia versus bronchiolitis)

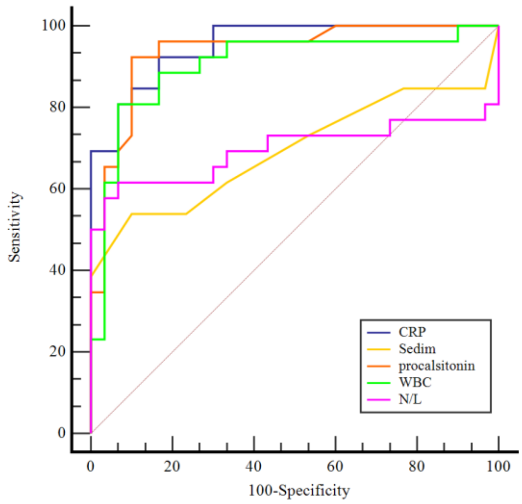


**Figure 2.** Performance of CRP, Sedimentation Rate, Procalcitonin, WBC, and N/L Variables in Predicting Pneumonia (Pneumonia vs. Control)

At a cutoff value of >12.63, WBC predicted pneumonia with a sensitivity of 70.0% (95% CI: 50.6-85.3) and a specificity of 76.6% (95% CI: 57.7-90.1). Table 3 presents the ROC analysis results for pneumonia versus control groups, where C-reactive protein (CRP) had the highest AUC of 0.714 (95% CI: 0.583-0.824, $p = 0.001$) **(Figure 2).** Using a cutoff value of >2.14 for CRP, pneumonia could be predicted with a sensitivity of 90.0% (95% CI: 73.5-97.9) and a specificity of 83.3% (95% CI: 67.2-93.8). Finally, **Table 4** summarizes the ROC curve analysis for bronchiolitis compared to the control groups. Procalcitonin demonstrated the highest AUC of 0.678 (95% CI: 0.545-0.793, p = 0.101) **(Figure 3).** With a cutoff value of >0.054, procalcitonin predicted bronchiolitis with a sensitivity of 80.0% (95% CI: 61.1-91.5) and a specificity of 83.3% (95% CI: 67.2-93.8). These analyses underscore the significant predictive value of WBC, CRP, and procalcitonin in distinguishing between pneumonia, bronchiolitis, and control groups, highlighting their potential utility in clinical practice.

## Discussion

Today, while deaths from infectious diseases are gradually decreasing with the widespread use of antibiotics and effective immunization policies, pneumonia and bronchiolitis still remain significant infections of the lower respiratory tract known to have a high risk of mortality and morbidity. The prediction of disease severity and clinical outcomes are prerequisites for managing health resources and providing adequate treatment options. This includes decisions about hospitalization or ICU admission, early discharge, and evaluation of antimicrobial therapy. Sheutz et al. demonstrated the need for additional prognostic markers to reduce the rate of unnecessary hospitalization.[18] IMA is a novel marker of acute coronary syndrome that has been associated with oxidative stress. Recent studies have revealed that it may be involved not only in acute coronary syndrome but also in many pathological processes that disrupt the balance between oxidant-antioxidant systems, including pneumonia. Lungs are among the organs most affected by oxidants and IMA levels are expected to be affected in pneumonia.

In our study, WBC, CRP, PCT, N/L ratio, PLT, and serum IMA levels were significantly higher in the group of patients with pneumonia than in the group of patients with bronchiolitis. In a study including 162 participants where IMA levels are measured in adult patients with pneumonia using a protocol quite similar to ours to assess the utility of IMA as a marker, the patient group was found to have significantly higher levels of CRP, WBC, neutrophil, platelet, and IMA than the control group.[22] In a study where Kimura et al. included 19 adult patients with respiratory tract infections, the mean IMA concentration was found to be significantly higher in the patient group.[23]

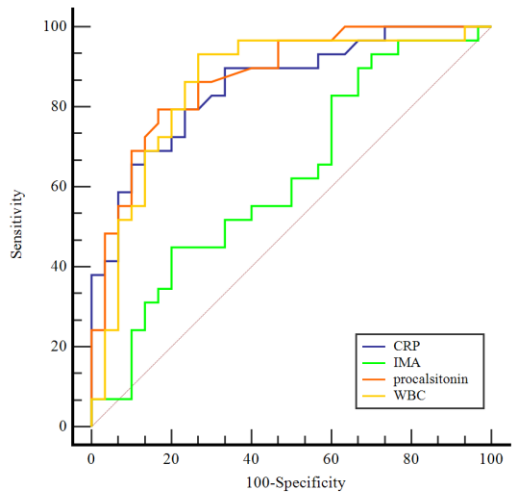


**Figure 3.** Performance of CRP, Sedimentation Rate, Procalcitonin, WBC, and N/L Variables in Predicting Bronchiolitis (Bronchiolitis vs. Control)

In another study, Kahveci et al. included 34 premature newborns with respiratory distress syndrome (RDS) in the patient group and 42 healthy preterm newborns in the control group. IMA levels were found to be significantly higher in the group of newborns with RDS compared with the control group. They concluded that elevated blood IMA levels may be considered as a useful marker for hypoxia in newborns with RDS.[24] In a study by Öztekin et al., the researchers included 43 healthy infants and 47 infants born after >37 weeks of gestation and diagnosed with TTN without any respiratory and cardiac symptoms and without any maternal health problems. IMA levels in the TTN group were found to be significantly higher[19]. In a study where Erdem et al. investigated IMA levels in adult patients with severe sepsis, serum IMA levels were reported to be significantly higher than in the healthy control group and serum CRP levels were positively correlated with IMA in the group of patients with severe sepsis.[25] In a very recent study by Karataş et al. including cases of welder's lung, IMA levels were found to be significantly higher in the patient group than in the healthy group.[26] Giannone et al. compared serum IMA levels in 127 hospitalized cirrhotic patients and 44 healthy controls. IMA was significantly higher in the group of patients with cirrhosis compared with the control group and in infected patients compared with uninfected patients. They proposed IMA as a new diagnostic test for bacterial infection.[27]

In our study, a possible relationship was noticed between IMA, PCT, and CRP in the pneumonia group. Table 2 and 3 show the results of the ROC Curve analyses for the pneumonia and bronchiolitis groups. According to this table, CRP has demonstrated significant diagnostic utility in differentiating pneumonia from control groups with high sensitivity and specificity. However, the direct comparison of CRP with IMA and PCT in our study showed different results across different groups. The most noteworthy result of our study is the diagnostic performance of IMA and procalcitonin. While IMA showed significant results, procalcitonin exhibited higher specificity in differentiating pneumonia from bronchiolitis.

First recorded in 1930, CRP is an acute phase reactant protein produced by the liver in response to most of the infections, inflammation, and tissue damage, often used as a sensitive yet non-specific marker of systemic inflammation.[28] In response to infection or tissue inflammation, CRP production is rapidly stimulated by cytokines, particularly interleukin (IL)-6, IL-1, and tumor necrosis factor.[29] Although its exact function in vivo is unknown, it is probably involved in the opsonization of infectious agents and damaged cells. Therefore, this protein has been recognized as a non-specific biomarker for early diagnosis and prognostic measurements.[30] However, CRP is also increased in many lung diseases, including infective pathologies such as pneumonia and noninfective pathologies such as malignancies, trauma, and pulmonary thromboembolism.[31] Specifically, CRP shows superior diagnostic value for bacterial infections with high plasma concentrations. However, CRP levels remain normal or only slightly increased during most viral infections.[32] A recently published study reported a significant association between CRP and mortality and identified CRP as an independent risk factor for complications and 30-day mortality.[33] Serum IMA levels, which correlated with CRP in our study, may be a biomarker that can be used like CRP in the diagnosis and follow-up of infectious processes such as pneumonia. In another study by Menendez et al., CRP and PCT values were found to be higher in patients with severe pneumonia and were associated with 30-day mortality.[34]

The limitation of this study is that it was conducted with a small group of patient. It is believed that more accurate results can be achieved with a larger group of patient

**Table 3.** ROC Curve Analysis Results for IMA, CRP, ESR, Procalcitonin, WBC, N/L, PLT, and Lactic Acid (Pneumonia vs. Control)

| | *AUC* (95 *CI* for *AUC*) | *p* | *Cutoff point* | *Sensitivty* (95 *CI* for *Sensitivty*) | *Specificity* (95 *CI* for *Specificity*) |
|---|---|---|---|---|---|
| IMA | 0.563 (0.429-0.691) | 0.396 | >193.4 | 66.6 (47.2-82.7) | 50.0 (31.3-68.7) |
| CRP | 0.947 (0.856-0.988) | <0.001 | >2.14 | 90.0 (73.5-94.4) | 83.3 (65.3-94.4) |
| SEDIM | 0.694 (0.557-0.810) | 0.011 | >7 | 53.8 (33.4-73.4) | 90.0 (73.5-97.9) |
| Procalsitonin | 0.939 (0.845-0.984) | <0.001 | >0.063 | 93.3 (77.9-99.2) | 90.0 (73.5-97.9) |
| WBC | 0.913 (0.812-0.970) | <0.001 | >10.3 | 83.3 (65.3-94.4) | 93.3 (77.9-99.2) |
| N/L | 0.696 (0.563-0.808) | 0.011 | >2.08 | 63.3 (43.9-80.1) | 90.0 (73.5-97.9) |
| PLT | 0.618 (0.484-0.741) | 0.105 | >458 | 36.6 (19.9-56.1) | 90.0 (73.5-97.9) |

*AUC*: Area under the curve, *CI*: Confidence Interval

**Table 4.** ROC Curve Analysis Results for IMA, CRP, Procalcitonin, WBC, N/L, PLT, and Lactic Acid (Bronchiolitis vs. Control)

| | *AUC* (95 *CI* for *AUC*) | *p* | *Cutoff point* | *Sensitivty* (95 *CI* for *Sensitivty*) | *Specificity* (95 *CI* for *Specificity*) |
|---|---|---|---|---|---|
| IMA | 0.623 (0.487-0.746) | 0.093 | ≤147.5 | 44.8 (26.4-64.3) | 80.0 (61.4-92.3) |
| CRP | 0.850 (0.734-0.929) | <0.001 | >1.27 | 80.0 (61.4-92.3) | 76.7 (57.7-90.1) |
| Procalsitonin | 0.876 (0.765-0.947) | <0.001 | >0.054 | 80.0 (61.4-92.3) | 83.3 (65.3-94.4) |
| WBC | 0.832 (0.713-0.916) | <0.001 | >8.0 | 90.0 (73.5-97.9) | 73.3 (54.1-87.7) |
| N/L | 0.552 (0.418-0.681) | 0.511 | ≤0.60 | 30.0 (14.7-49.4) | 100.0 (88.4-100.0) |
| PLT | 0.589 (0.453-0.716) | 0.249 | ≤292 | 48.2 (29.4-67.5) | 76.6 (57.7-90.1) |

*AUC*: Area under the curve, *CI*: Confidence Interval

## Conclusions

In our study examining pneumonia and bronchiolitis, we think that IMA levels may be a useful parameter for differential diagnosis between pneumonia and bronchiolitis in comparison with other biomarkers used in the diagnosis. Since our study did not yield mortality-related outcomes, further research is needed to understand the relationship between IMA levels and mortality. Additionally, considering that IMA is similar to other biomarkers in terms of cost, IMA may be a more utile parameter in the future.

## Declarations

***Ethics approval and consent to participate***

Ethical approval was obtained for this prospective and case-control study with the Clinical Research Ethics Committee of Kartal Lütfi Kırdar City Hospital Decision No. 2021/s14/214/1 of 30th November, 2021.

***Conflict of Interest Statement***

The authors declare no conflicts of interest in preparing this paper.

***Funding information***

This research received no specific grants from any funding agency in the public, commercial, or not-for-profit sectors.

***Data availability statement***

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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