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Diagnostic value of pentraxin-3 in community-acquired pneumonia patients presenting to the emergency department

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ABSTRACT

Aims: Community-acquired pneumonia (CAP) is one of the most frequent causes of emergency department admissions and represents a major infectious disease requiring rapid diagnosis. This study aimed to evaluate the diagnostic value of pentraxin-3 (PTX-3) in patients presenting to the emergency department with CAP and to investigate its association with conventional inflammatory biomarkers and the pneumonia severity score based on confusion, urea, respiratory rate, blood pressure, and age ≥65 years (CURB-65).

Methods: This prospective, single-center study included 45 adult patients diagnosed with CAP and 42 healthy controls. Demographic characteristics and laboratory parameters, including white blood cell count, C-reactive protein (CRP), procalcitonin (PCT), and PTX-3 levels, were recorded. Diagnostic performance was evaluated using receiver operating characteristic (ROC) analysis, and correlations between PTX-3 and clinical parameters were analyzed.

Results: Median PTX-3 levels were significantly higher in the CAP group compared with controls (2.485 ng/ml vs. 0.981 ng/ml, $p<0.001$). ROC analysis demonstrated a high diagnostic performance of PTX-3 for distinguishing CAP patients from controls (AUC: 0.906; 95% CI: 0.846–0.965). An optimal cut-off value of 1.389 ng/ml yielded high sensitivity (93.33%) and acceptable specificity (73.17%). PTX-3 levels showed no significant correlation with CRP, PCT, white blood cell count, or CURB-65 score and did not differ significantly across CURB-65 severity groups.

Conclusion: PTX-3 appears to be a useful biomarker for identifying the presence of CAP rather than assessing disease severity or prognosis. Its high sensitivity suggests that PTX-3 may support early diagnosis and rapid clinical decision-making in time-critical emergency department settings.

Keywords: Community-acquired pneumonia, pentraxin-3, biomarkers, emergency department

INTRODUCTION

Community-acquired pneumonia (CAP) is a major global health problem frequently encountered in emergency departments and is associated with high morbidity and mortality worldwide.[1] Delays in early diagnosis and initiation of appropriate treatment, particularly in elderly patients and those with comorbid conditions, may lead to adverse clinical outcomes. Therefore, the rapid and accurate identification of CAP in the emergency department setting, along with timely initiation of appropriate therapy, is of critical importance for improving disease course and patient outcomes.

Several clinical scoring systems have been developed to assess disease severity and to guide decisions regarding the appropriate site of care for patients with pneumonia. Among these, the CURB-65 score—which includes parameters such as confusion, uremia, respiratory rate, blood pressure, and age—is particularly favored in emergency department settings due to its practical applicability and ability to provide rapid clinical guidance.[2] In recent years, the COVID-19 pandemic has substantially increased the burden of pneumonia on emergency departments and highlighted the vulnerability of healthcare systems to large-scale respiratory outbreaks. Moreover, growing scientific evidence suggests that similar pandemics may occur in the future, further emphasizing the need for rapid and reliable diagnostic approaches in the emergency setting.[3,4] In this context, it has been reported that emergency departments with high patient volumes require not only clinical pneumonia severity scores but also simpler, more practical inflammatory biomarkers with high predictive value to support rapid clinical decision-making.[5] In CAP, biochemical markers such as C-reactive protein (CRP) and procalcitonin (PCT) are widely used to assess disease severity and monitor response to treatment.[6] However, the diagnostic accuracy of these biomarkers, particularly their sensitivity in the early stages of the disease, remains controversial.

Therefore, there is an ongoing need for novel biomarkers that can reflect the presence and severity of infection more rapidly and accurately in patients with CAP. In this context, pentraxin-3 (PTX-3), a long pentraxin and an acute-phase protein involved in the innate immune response to infection and inflammation, has recently attracted attention as a potential diagnostic biomarker in CAP. Moreover, PTX-3 has been reported to increase earlier than CRP in conditions such as acute lung injury and pneumonia and may be associated with disease severity and mortality.[7,8]

The aim of this study was to investigate the diagnostic value of PTX-3 in patients with CAP presenting to the emergency department. In addition, we aimed to evaluate the association of this biomarker with commonly used inflammatory markers, such as CRP and PCT, as well as with the CURB-65 pneumonia severity score.

METHODS

Ethics

Approval for the study was obtained from the Ankara Numune Training and Research Hospital Clinical Researches Ethics Committee (Date: 18.04.2019, Decision No: E-19-2667). The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants and/or their legal representatives prior to enrollment.

Study Design and Setting

This prospective study was conducted in the Emergency Medicine Department of a tertiary care hospital. Adult patients diagnosed with CAP who presented to the Emergency Department of Ankara Numune Training and Research Hospital between April 1 and June 1, 2019 were included in the study.

Study Population

Patients aged 18 years and older who presented to the emergency department and were diagnosed with CAP based on clinical, laboratory, and radiological findings were included in the study. The patient group consisted of 45 individuals who met these criteria and agreed to participate in the study. The control group comprised 42 healthy volunteers aged 18 years and older with no known acute or chronic systemic disease. Inclusion criteria were age ≥18 years and a diagnosis of CAP supported by clinical, laboratory, and/or radiological findings. Exclusion criteria included age under 18 years, receipt of immunosuppressive therapy within the previous month, history of active malignancy, pregnancy, trauma-related admission, and hospitalization for any reason within the preceding week.

Data Collection

All patient data were recorded prospectively. In the patient group, sociodemographic characteristics (age and sex), vital signs, white blood cell (WBC) count, neutrophil count, lymphocyte count, CRP, PCT and PTX-3 levels were recorded. The CURB-65 score was calculated for all patients in the CAP group. In the control group, sociodemographic characteristics and only PTX-3 levels were evaluated.

Definition

Diagnosis of pneumonia: Patients presenting to the emergency department with symptoms of lower respiratory tract infection, including fever, cough, dyspnea, sputum production, and general deterioration, were considered suspected cases of pneumonia. Patients with acute elevations in inflammatory markers accompanying clinical findings and radiological features consistent with pneumonia on thoracic computed tomography were included in the study with a diagnosis of CAP.[1] Microbiological testing was not systematically incorporated into the study protocol, and etiological classification of pneumonia (bacterial, viral, or atypical) was not performed.

The CURB-65 score was used to assess pneumonia severity. The score consists of the following criteria: presence of confusion, blood urea level >7 mmol/L, respiratory rate ≥30 breaths/min, systolic blood pressure <90 mmHg or diastolic blood pressure ≤60 mmHg, and age ≥65 years. One point was assigned for each criterion, and the total score was calculated accordingly. CURB-65 scores were classified as low risk (0–1), moderate risk (2), and high risk (≥3).[2]

Measurement of pentraxin-3: PTX-3 levels were measured using the enzyme-linked immunosorbent assay (ELISA) method with a commercially available human PTX-3 ELISA kit (YLA0361HU, Shanghai YL Biotech Co., Ltd.), in accordance with the manufacturer's instructions. The assay had a measurement range of 0.1–30 ng/ml and an analytical sensitivity of 0.05 ng/ml.

Outcomes

The primary outcome of this study was to assess the diagnostic value of PTX-3 in patients with CAP presenting to the emergency department. The secondary outcomes were to evaluate the association between PTX-3 levels and established inflammatory biomarkers, including CRP and PCT, as well as the CURB-65 pneumonia severity score.

Statistical Analysis

The data analyses were performed using SPSS (Statistical Package for the Social Sciences) for Windows, version 16.0 (SPSS Inc., Chicago, IL, USA). The normality of data distribution was assessed using the Shapiro–Wilk test. Descriptive statistics were presented as mean±standard deviation for normally distributed variables and as median with interquartile range (IQR) for non-normally distributed variables. Categorical variables were expressed as numbers and percentages. Comparisons between two independent groups were performed using the Mann–Whitney U test for non-normally distributed continuous variables and the Chi-square test or Fisher's exact test for categorical variables. For comparisons among more than two independent groups with non-normally distributed variables, the Kruskal–Wallis test was used, followed by Bonferroni correction for post hoc pairwise comparisons. The diagnostic performance of PTX-3 was evaluated using receiver operating characteristic (ROC) curve analysis, and sensitivity, specificity, positive predictive value, and negative predictive value were calculated. Correlation analyses for non-normally distributed variables were conducted using Spearman's rank correlation test. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 45 patients diagnosed with CAP and 42 healthy volunteers as the control group were included in the study. Baseline demographic characteristics and PTX-3 levels were compared between the patient and control groups. There

was no statistically significant difference between the groups in terms of gender distribution (p=0.358). The median age of the patient group was 76 years (IQR: 63–81), whereas the median age of the control group was 31 years (IQR: 26–34). The patient group was significantly older than the control group (p<0.001). PTX-3 levels were significantly higher in the patient group compared with the control group. The median PTX-3 level was 2.485 ng/ml (IQR: 1.870–3.427) in the patient group and 0.981 ng/ml (IQR: 0.520–1.583) in the control group (p<0.001) (Table 1).

Table 1. Comparison of demographic characteristics and pentraxin-3 levels between patient and control groups

Variable	Control group (n=42)	Patient group (n=45)	p-value
Gender, n (%)			
Male	25 (61.0)	23 (51.1)	0.358[a]
Female	16 (39.0)	22 (48.9)	
Age, years (median, IQR)	31 (26–34)	76 (63–81)	<0.001[b]
Pentraxin-3, ng/ml (median, IQR)	0.981 (0.520–1.583)	2.485 (1.870–3.427)	<0.001[b]

[a] Chi-square test, [b] Mann–Whitney U test, IQR: Interquartile range

ROC analysis was performed to evaluate the ability of PTX-3 to discriminate between patients and controls. The area under the curve (AUC) was 0.906 (95% confidence interval: 0.846–0.965), indicating excellent diagnostic performance, and the result was statistically significant (p<0.001) (Figure). Sensitivity, specificity, positive predictive value, and negative predictive value for different cut-off points are presented in Table 2. The highest Youden Index was observed at a cut-off value of 1.389 ng/ml (Table 2).

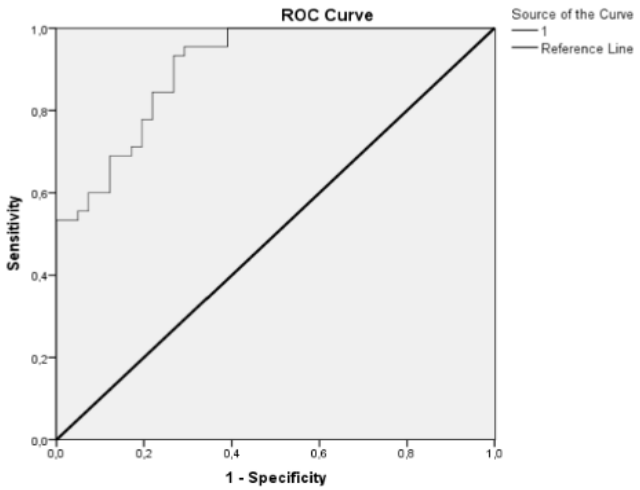

Figure. Receiver operating characteristic (ROC) curve of pentraxin-3 for distinguishing community-acquired pneumonia patients from controls

To evaluate the relationships between the studied biomarkers and the CURB-65 score, Spearman correlation analysis was performed. The analysis revealed that PTX-3 levels were not significantly correlated with PCT, CRP, WBC count, neutrophil count, lymphocyte count, or the CURB-65 score (all p>0.05) (Table 3).

Patients were categorized into low- (0–1 points), moderate- (2 points), and high-risk (3–5 points) groups according to their CURB-65 scores to assess pneumonia severity. The distribution of laboratory parameters across these severity groups was compared using the Kruskal–Wallis test. The analysis demonstrated that median PTX-3 levels did not differ significantly among the CURB-65 groups (p=0.411). In contrast, plasma PCT and CRP levels increased significantly with increasing pneumonia severity (p=0.001 and p=0.026, respectively). Bonferroni-adjusted post hoc analysis revealed that the significant difference in PCT levels was primarily driven by the high-risk group (CURB-65 ≥3). No significant differences were observed among CURB-65 groups with respect to WBC count, neutrophil count, or lymphocyte count (Table 4).

Table 2. Diagnostic performance of pentraxin-3 at different cut-off values in community-acquired pneumonia

Cut-off value (ng/ml)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Youden Index
1.339	95.56	70.73	78.18	93.55	0.663
1.389	93.33	73.17	79.25	90.91	0.665
1.469	91.11	73.17	78.85	88.24	0.643
1.501	88.89	73.17	78.43	85.71	0.621
1.687	84.44	78.05	80.85	82.05	0.625

PPV: Positive predictive value, NPV: Negative predictive value

DISCUSSION

In this study, the diagnostic value of PTX-3 was evaluated in patients with CAP presenting to the emergency department, and PTX-3 demonstrated a high diagnostic performance in distinguishing patients from healthy controls. In contrast, PTX-3 levels were not significantly associated with the CURB-65 score, which reflects pneumonia severity. These findings suggest that PTX-3 may serve as a useful biomarker for identifying the presence of CAP rather than for assessing disease severity or prognosis.

In our study, the median age of patients diagnosed with CAP being in the eighth decade was consistent with the known epidemiology of the disease. It has been well documented in the literature that the incidence and severity of CAP increase with advancing age, with a marked rise in hospitalization rates and mortality, particularly among individuals aged 65 years and older.[9] Similarly, in a multicenter study including patients with CAP, the mean age was reported as 76.8 years, supporting the age distribution observed in our study.[10]

In the this study, the substantial age difference between the patient and control groups suggests that PTX-3 levels may have been influenced not only by the presence of pneumonia but also by age-related physiological changes. It is well established that aging is associated with alterations in inflammatory response dynamics and that baseline levels of certain inflammatory biomarkers, such as CRP, may increase with advancing age.[11] Therefore, the observed difference in PTX-3 levels should be interpreted with caution, as it may not be entirely attributable to pneumonia alone. In this study, the significantly higher PTX-3 levels observed in the patient group compared with the control group support the potential diagnostic value of PTX-3 in distinguishing the presence of pneumonia, despite the age difference between the groups. The ROC analysis and diagnostic performance

Table 3. Correlation analysis between pentraxin-3 and clinical and laboratory parameters

Parameter		PCT	CRP	WBC	Neutrophil	Lymphocyte	CURB-65
PTX-3	p-value	-0.181	-0.168	-0.077	-0.116	0.151	0.014
	rho	0.233	0.269	0.617	0.450	0.323	0.929

PCT: Procalcitonin, CRP: C-reactive protein, WBC: White blood cell count, CURB-65: Confusion, urea >7 mmol/L, Respiratory rate ≥30/min, low blood pressure, age ≥65 years; PTX-3: Pentraksin-3 (rho: Spearman's correlation coefficient).

Table 4. Distribution of laboratory parameters according to CURB-65 score groups

Parameter	CURB-65 score=0–1 (n=6) (median, IQR)	CURB-65 score=2 (n=12) (median, IQR)	CURB-65 score ≥3 (n=27) (median, IQR)	p-value
Pentraxin-3 (ng/ml)	2.18 (1.34–2.62)	2.47 (2.03–3.69)	2.61 (1.85–3.43)	0.411
Procalcitonin (ng/ml)	0.02 (0.00–0.78)	0.08 (0.04–0.56)	2.10 (0.60–9.90)	0.001
C-reactive protein (mg/L)	60.5 (33–148)	51.0 (37.5–88.5)	103.0 (70–275)	0.026
White blood cell count (×10^9/L)	9.2 (7.2–10.5)	10.7 (7.3–13.5)	13.0 (7.5–17.5)	0.213
Neutrophil count (×10^9/L)	7.3 (6.3–8.1)	8.4 (4.6–11.1)	10.6 (6.0–15.6)	0.189
Lymphocyte count (×10^9/L)	1.40 (0.60–1.80)	1.45 (1.10–2.35)	1.00 (0.60–1.60)	0.125

CURB-65: Confusion, urea >7 mmol/L, respiratory rate ≥30/min, low blood pressure, age ≥65 years, Kruskall Wallis test (with Bonferroni correction), IQR: Interquartile range

metrics across different cut-off values further reinforce this finding, demonstrating that PTX-3 has high sensitivity and acceptable specificity in discriminating patients from healthy individuals. This high diagnostic performance can likely be explained by the underlying pathophysiological mechanisms related to the unique synthesis and release characteristics of PTX-3 at the site of inflammation. Unlike classical short pentraxins such as CRP, PTX-3 is not primarily synthesized in the liver as an acute-phase reactant; rather, it is rapidly produced at the site of inflammation or infection by various immune and structural cells, including macrophages, dendritic cells, neutrophils, and endothelial cells.[12] In the presence of a pathogen causing pneumonia within lung tissue, PTX-3 released from these local cells plays a critical role in the early innate immune response. Acting as a pattern recognition molecule, PTX-3 recognizes microorganisms, facilitates the process of opsonization, and contributes to pathogen clearance through activation of the complement system.[13] Therefore, elevated plasma PTX-3 levels are more likely to reflect local and early inflammatory activity within the lung parenchyma rather than a liver-derived systemic inflammatory response. These biological properties help explain why PTX-3 emerges as a sensitive biomarker for the diagnosis of CAP, particularly in the early stages of infection.

In our study, the optimal cut-off value of 1.389 ng/ml for PTX-3 demonstrated high sensitivity and acceptable specificity. The high sensitivity observed in our study suggests that PTX-3 may serve as a supportive biomarker in the early diagnostic evaluation of pneumonia in emergency department settings. However, given its moderate specificity, it should not be considered a stand-alone rule-out test. Furthermore, the literature indicates that reported AUC values and cut-off points for the diagnostic performance of PTX-3 vary widely across studies. In a study by Shi et al.[14] evaluating patients with CAP, the optimal cut-off value for PTX-3 was identified at a markedly higher level of 32.26 ng/ml. In contrast, a study conducted in Egypt including patients with lower respiratory tract infections reported an AUC value for PTX-3 that was largely comparable to our findings.[15] Moreover, a recent meta-analysis including respiratory tract infections emphasized that the reported cut-off values for PTX-3 ranged widely from 0.3 to 100 ng/ml; this heterogeneity was attributed to differences in patient populations, sampling timing, and measurement methods used across studies.[16]

In our study, no significant correlation was observed between PTX-3 levels and CRP, PCT, WBC count, or the CURB-65 score. Similarly, no significant differences in PTX-3 levels were detected among severity groups stratified according to CURB-65 scores; in contrast, CRP and PCT levels increased significantly with higher CURB-65 scores. It is well established that biomarkers such as CRP and PCT are primarily associated with systemic inflammatory burden and disease severity.[17,18] Therefore, their parallel increase with the CURB-65 score—which reflects clinical severity and mortality risk—was an expected finding. In contrast, the local synthesis of PTX-3 at the site of infection rather than a systemic inflammatory response explains its primary diagnostic role in the early identification of infection rather than in reflecting the degree of systemic inflammation.[19] In the literature, PTX-3 has been reported to increase early in infectious diseases such as pneumonia and sepsis and to have diagnostic value; however, its correlation with disease severity scores and conventional inflammatory markers appears to be limited.[16,20]

Limitations

This study has several limitations. The substantial age difference between the patient and control groups represents one of the most important methodological limitations of our study. Age-related alterations in immune response and potential physiological differences in inflammatory biomarkers may have acted as confounding factors influencing PTX-3 levels. Therefore, our findings should be interpreted with caution. Second, the etiological pathogen responsible for pneumonia (bacterial, viral, or atypical) was not identified. Given that different pathogens may elicit distinct host immune responses and varying PTX-3 levels, pathogen-specific subgroup analyses could further clarify the diagnostic role of PTX-3. Despite these limitations, our study

provides valuable evidence regarding the potential utility of PTX-3 in the diagnosis of CAP in the emergency department setting.

CONCLUSION

This study demonstrated that PTX-3 stands out as a diagnostic biomarker for distinguishing the presence of disease rather than reflecting disease severity or prognosis. This feature suggests that PTX-3 may be a useful tool to support clinical decision-making processes for the early diagnosis of CAP, particularly in busy and time-constrained emergency department settings. The findings lay the groundwork for larger, multicenter, prospective studies to determine the clinical utility of PTX-3 and its optimal use strategies.

ETHICAL DECLARATIONS

Ethics Committee Approval

Approval for the study was obtained from the Ankara Numune Training and Research Hospital Clinical Researches Ethics Committee (Date: 18.04.2019, Decision No: E-19-2667).

Informed Consent

Written informed consent was obtained from all individual participants prior to their inclusion in the study. Participants were fully informed about the study's aims, procedures, potential risks and benefits, and their rights—including the right to withdraw at any time without consequence. All participants voluntarily signed a written informed consent form.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

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Author Contributions

Concept: ES, UBK; Design: UBK; Control: ES; Resources: ES, UBK; Materials: AK; Data Collection and/or Processing: UBK, AK; Analysis and/or Interpretation: UBK, ES; Literature Review: ES, UBK; Writing the Article: ES, UBK, AK; Critical Review: ES, UBK, EK.

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