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Platelet Count as a Predictor for Community-Acquired Pneumonia Severity Using PSI Score

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Abstract

Community-Acquired pneumonia (CAP) refers to the inflammation of the lung parenchyma that is contracted outside of a hospital setting. In addition, in developing countries, it is among the top three causes of death worldwide. Pneumonia severity is often assessed using various instruments, including Pneumonia Severity Index (PSI). Furthermore, the platelet play a crucial role in both hemostasis and the defense of the body against infectious agents. A relatively inexpensive and routinely conducted test, namely the platelet count serves as a supporting examination. Therefore, this study aimed to determine the potential correlation between the platelet count and CAP severity.

Aims: The objective of this study was to investigate the potential role of platelet count as a predictive factor for evaluating the severity of CAP patients using PSI scores.

Methodology: An analytical observational study with a retrospective cross-sectional design was conducted on patients diagnosed with CAP at Dr. Moewardi General Hospital Surakarta from October 2022 to May 2023. Patients data were extracted from medical records. The correlation between the platelet count and CAP severity was analysed using the Spearman correlation test. The platelet count cut-off value was determined using Receiver Operating Characteristic (ROC) curve.

Results: In this study, there were 183 subjects with an average age of 56.90 and a platelet count of 272,688.52 (SD $\pm$ 157,524.87). The CAP severity was dominated by the moderate-severe category (52.5%). The platelet count was negatively correlated with severity based on PSI score with $p=0.029$ ($p<0.05$) and $r=0.162$ (low correlation value). Based on ROC curve, AUC value = 0.594 (very weak predictor) and the platelet count cut-off value was 152,000 (sensitivity = 0.322, specificity = 0.91).

Scientific Novelty: There is a correlation between the platelet count and the severity of CAP based on the PSI score.

Conclusion: A significant correlation was found between the platelet count and CAP severity based on PSI score. However, the platelet count could not be used as a reliable predictor of CAP severity.

Keywords: Platelet Count;

Community-Acquired Pneumonia Severity
PSI Score

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Introduction

Community-Acquired Pneumonia (CAP) is the third leading cause of death globally, with a significant impact on mortality and sepsis in developing countries [1]. In addition, it is an inflammation of the lung parenchyma acquired in the community or is contracted outside of a hospital setting [2]. Pneumonia occurs more often in patients with several risk factors such as advanced age, immunosuppression, commodities, and lifestyle [3]. CAP can be caused by a variety of pathogens such as bacteria, viruses, or fungi. Common symptoms are fever, shortness of breath, chest pain, cough with phlegm, and weight loss. The incidence of this medical condition in the world is estimated to vary between 1.5 and 14 cases/1000 people/year [4]. In the United States, the incidence is reported to be 24.8 cases/10,000 adults, where the increasing trend is associated with age [4]. CAP is the eighth leading cause of death in the United States [5].

Nationally, the prevalence of pneumonia according to diagnosis by health workers, including doctors, midwives, or nurses, is estimated at 2% [6]. In Surakarta, the prevalence of pneumonia based on diagnosis by health workers is estimated at 1.86% [7].

Pneumonia severity is often assessed using several instruments, particularly Pneumonia Severity Index (PSI). This instrument helps doctors to determine patient treatment options, either outpatient or inpatient [8]. Components contained in PSI are demographic factors, and comorbidities, including physical, laboratory, and radiographic examination with a total of 20 variables [9]. Furthermore, PSI instrument has higher accuracy compared to CURB-65 instrument in assessing the prognosis of CAP patients due to the comprehensive inclusion of variables [9].

Platelet plays a crucial role in the hemostasis process and the body defense against infectious agents. The level of platelet in the blood, namely the platelet count, is measured through a complete blood count test, serving as a relatively cheap, easily accessible, and routine supportive examination [1,10].

A previous study found that the platelet count abnormalities were a better predictor of severity and clinical outcomes in CAP compared to leukocyte count. Patients with below normal platelet levels or thrombocytopenia have an association with the incidence of sepsis and the need for ICU care. Thrombocytopenia can result from increased platelet destruction/elimination or decreased platelet production. When platelets are activated, their lifespan is shortened, so they are rapidly eliminated from the blood circulation. [1,10]. Furthermore, it was discovered that CAP patients with lower platelet count were associated with a higher degree of severity based on CURB-65 instrument compared to those with normal or higher [11].

Despite the high incidence of pneumonia in Indonesia, there is still limited information on the correlation between platelet count and CAP severity based on PSI score. Consequently, this study aimed to determine, the correlation between platelet count and CAP severity in patients based on PSI score at Dr. Moewardi General Hospital Surakarta.

Research Problem

Despite the high incidence of pneumonia in Indonesia, there is still limited information on the correlation between platelet count and CAP severity based on PSI score. Consequently, this study aimed to determine, the correlation between the platelet count and CAP severity in patients based on PSI score at Dr. Moewardi General Hospital.

Research Focus

Community-acquired pneumonia patients at Dr. Moewardi General Hospital Surakarta, Central Java, Indonesia, who met the inclusion and exclusion criteria were involved in the study.

Research Aim and Research Questions

The objective of this study was to investigate the relationship between the platelet count and the severity of community-acquired pneumonia patients, as predicted by PSI scores. Can the platelet count be used to predict the severity of community-acquired pneumonia patients based on PSI scores?

Research Methodology

General Background

An analytical observational method with a retrospective cross-sectional design was used in the study. The data used included the results of routine blood tests and CAP severity based on PSI score obtained from medical records of patients at Dr. Moewardi General Hospital Surakarta. The purposive sampling method was used by selecting samples that met the inclusion and exclusion criteria. The inclusion criteria were hospitalised CAP patients, those receiving routine blood tests, and aged over 18 years. The exclusion criteria were patients infected with HIV, having a history of blood disorders such as ITP, leukemia, aplastic anemia, dengue fever, and malaria, those diagnosed with tuberculosis, with incomplete medical record data, and those being confirmed positive for COVID-19.

Data Analysis

The variables examined in the study were the platelet count and the severity of CAP. The platelet count refers to a laboratory test conducted to measure the quantity of platelets present in the blood. Normal platelet levels range between 150,000-400,000/ μ l. Subsequently, CAP severity was measured using PSI instrument. The degree of severity based on PSI score was divided into 5 risk categories, with classes I, II, and III being low, IV being medium, and V indicating high risk. In this study, the severity degree was grouped into two, namely classes I, II, and III which were included in the mild degree, while classes IV and V were included in the moderate-severe degree. The Spearman correlation test was used to determine the correlation between the platelet count and CAP severity. p-value of <0.05 was considered statistically significant. The platelet count cut-off value was determined using Receiver Operating Characteristic (ROC) curve, sensitivity, and specificity values.

Research Results

Data from 183 patients who were diagnosed with CAP at Dr. Moewardi General Hospital Surakarta between October 2022 and May 2023 were analysed in this study. The platelet count checked was found to meet the inclusion and exclusion criteria. The obtained samples were divided into 2 groups based on the severity degree according to PSI score. The first group consisted of 87 patients who were included in the mild degree category, while the second group consisted of 96 patients included in the moderate-severe category. The results showed that the mean platelet count was 272,688.52 (SD $\pm$ 157,524.87) with the highest value being 906,000/ μ l and the lowest value at 11,000/ μ l. The mean age of patients was 56.90 (SD $\pm$ 15,556), with a minimum age of 18 years and a maximum age of 93 years.

Table 1. Characteristic Distribution

Characteristics	Frequency	Percentage (%)
Gender		
Male	93	50.8%
Female	90	49.2%
Age		
< 65 years old	119	65%
$\geq$ 65 years old	64	35%
Comorbidities		
Yes	153	83.6%
No	30	45.9%
Pneumonia Severity		
Mild	87	47.5%
Moderate-Severe	96	52.5%
Platelet Count		
Thrombocytopenia	35	19.1%
Normal	126	68.9%
Thrombocytosis	22	12%

Source : authors' own development

Based on Table 1, the subjects were dominated by males with a total of 93 patients (50.8%). According to age, there were more patients 119 (65%) aged less than 65 years, with the majority having comorbid. The division of severity groups based on PSI score showed that there were more patients 96 (52.5%) with the moderate-severe degree. Based on the division of platelet count groups, the majority of patients 126 (68.9%) had normal platelet count.

Table 2. Multivariate Analysis between Comorbidities and Severity

Comorbidities (PSI)	Severity (PSI)	
	Sig. (p)	OR
Malignancy	0.038	3.059
Liver Disease	0.038	4.423
Congestive Heart Disease	0.153	1.935
Cerebrovascular Disease	0.016	3.263
Kidney Disease	0.000	8.936

Source : authors' own development

The logistic regression test was used to determine the correlation between comorbidities contained in PSI and the severity degree based on PSI score. A significance value <0.05 showed that comorbidities had a significant correlation with severity degree. Table 2 shows that malignancy, liver disease, disease, cerebrovascular disease, and kidney disease have a significant correlation with the severity degree, at a significance value of <0.05 . Furthermore, the largest odds ratio (OR) value was found to be kidney disease. This means that patients with kidney disease are 8,936 times more likely to suffer from moderate-severe community-acquired pneumonia.

Table 3 displays the distribution of platelet count groups categorised by severity. Among the 126 patients in the normal group, 73 (57.9%) were classified as mild and 53 (42.1%) as moderate-severe.

Table 3. Distribution of Platelet Count Groups by Severity Degree

Distribution	Severity	
	Mild N (%)	Moderate- Severe N (%)
The Platelet Count		
Thrombocytopenia	6 (17.1%)	29 (82.9%)
Normal	73 (57.9%)	53 (42.1%)
Thrombocytosis	8 (36.3%)	14 (63.7%)

Source : authors' own development

The relationship between the platelet count and CAP severity was analysed using the Spearman correlation test. The interpretation of the correlation test results showed a value of $p=0.029$, implying a significant correlation between the platelet count and the severity degree based on PSI score, as $p<0.05$. The correlation coefficient value was 0.162, showing that the two variables had a weak relationship, as the values ranged from 0.00 - 0.25. The negative correlation coefficient showed a unidirectional relationship, implying that as platelet count decreased, severity value based on PSI the score tended to increase.

The platelet count cut-off value was determined using ROC curve presented in Figure 1.

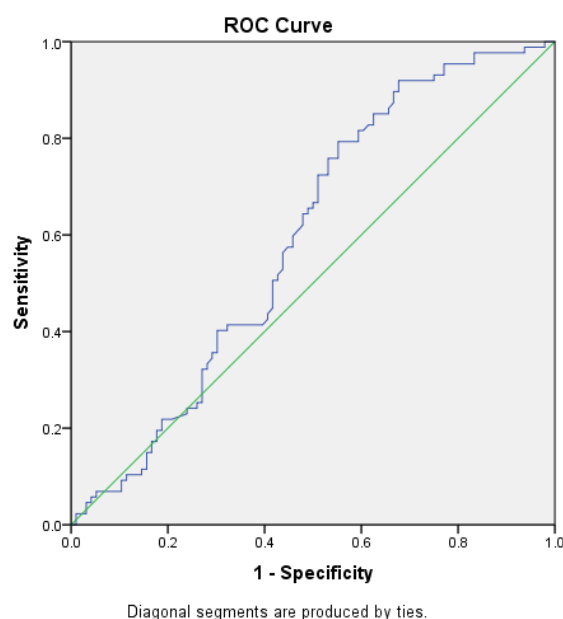


Figure 1. ROC Curve

Source: authors' own development

According to the analysis of the Receiver Operating Characteristic (ROC) curve, the Area Under the Curve (AUC) value was found to be 0.594 (95%CI=0.511-0.676), with a significant p-value of 0.029 ($p < 0.05$). A higher AUC value, closer to 1, indicates a stronger predictive ability.

The results suggest that the platelet count is a very weak predictor of Community-Acquired Pneumonia (CAP) severity, as determined by the Pneumonia Severity Index (PSI) score. To establish a cut-off value for the platelet count, the Youden Index, calculated as the sum of sensitivity and specificity minus one, was employed. This calculation yielded a cut-off value of 152,000 platelets.

Based on the cut-off value on ROC curve, the platelet count was divided into 2 groups, namely $< 152,000$ and $\geq 152,000$. Therefore, the obtained cross-tabulation results are presented in Table 4.

Table 4. Crosstab (2x2)

Platelet Count	Moderate-Severe	Mild	Total
$< 152,000$	31 ^a	7 ^b	38
$\geq 152,000$	65 ^c	80 ^d	145
Total	96	87	183

Description: a: true positive value; b: false positive value; c: false negative value; d: true negative value

Source: authors' own development

The crosstab results were used to determine sensitivity, specificity, positive, and negative predictive value using the formula sequentially, namely $a/(a+c)$; $d/(b+d)$; $a/(a+b)$; $d/(c+d)$. The results showed that sensitivity value = 0.322, specificity = 0.919, positive predictive value = 0.815, and negative predictive value = 0.551.

Discussion

This study analyzed data from 183 patients diagnosed with CAP at Dr. Moewardi General Hospital Surakarta in the period October 2022 to May 2023. The platelet count was checked, which met the inclusion and exclusion criteria. The results showed that CAP occurred more frequently in men than women, with a percentage of 50.8%. Additionally, CAP in the moderate-severe severity category was dominated by men. This could be explained by previous investigations, where the incidence of CAP was more common in men (51.7%) compared to women [12,13]. The significant increase is related to men lifestyles capable of increasing the risk of developing pneumonia, such as smoking, alcohol consumption, and drug abuse. In addition, estrogen in women affects levels of nitric oxide synthases (NOS-3), as it can trigger the production of reactive nitrogen intermediates (RNI) in macrophages capable of killing bacteria. This phenomenon contributes to a lower incidence of CAP in women compared to men [14-16].

In this study, it was found that CAP occurred more frequently in the age group < 65 years, consisting of 119 patients. In previous study, there were more patients aged < 65 years (64%) than those aged ≥ 65 years [17]. In

patients aged ≥ 65 years, symptoms such as fever, chest pain, and cough often do not appear, thereby increasing the risk of undiagnosis [18]. However, other studies stated that patients aged ≥ 65 years had a higher incidence. This is a decrease in the function of the natural and adaptive immune system, including a high prevalence of multimorbidity in the elderly. A significant decrease has been discovered in airway protective sensitivity such as coughing [19,20].

Based on the distribution of comorbidities, there were more patients with comorbidities than those without comorbidities. In this study, 153 patients had comorbidities samples, thereby increasing the risk of CAP. Some of these comorbidities include chronic obstructive pulmonary disease (COPD), diabetes, and heart disease [15,21-23]. In patients with diabetes, a decrease in diffusion capacity was observed due to pulmonary microvascular disorders, thereby increasing CAP severity [24]. Other comorbidities such as COPD increase the risk of CAP due to the use of inhaled corticosteroids, which are capable of reducing the systemic inflammatory response [25].

The presence of comorbidities can also increase the mortality rate of community-acquired pneumonia patients [26]. As presented in Table 2, approximately 52 patients with kidney disease had the largest number. The results of a multivariate analysis between comorbidities and severity showed that patients with comorbid kidney disease had the highest OR, namely 8.936. This showed that patients with kidney disease were 8,936 times more prone to suffer from moderate-severe CAP. Previous study stated that patients with kidney disease have a higher risk of developing pneumonia and increased severity compared to other comorbidities such as chronic obstructive pulmonary disease (COPD), asthma, or diabetes mellitus (DM). In patients with chronic kidney disease, the body immune function decreases, with the condition of uremia disrupting the function of neutrophils and lymphocytes. Additionally, patients receiving hemodialysis therapy have an increased risk of developing infections due to vascular access, injectable drugs, and exposure to other equipment [27,28].

Based on Table 4, it was found that 126 patients with normal platelet count constituted the largest sample group. Subsequently, the second largest group was patients with thrombocytopenia, followed by those with thrombocytosis. This is similar to other studies, where patients with normal platelet count were the largest group (75%), followed by those with thrombocytopenia (17.5%), and thrombocytosis (7.5%), respectively [10]. The results of analysis using the Spearman correlation test showed a significant correlation between platelet count and CAP severity based on PSI score. The correlation coefficient value was obtained at -0.162, showing that lower platelet count increases CAP severity in patients. Other studies explained that the conditions of infection or inflammation would trigger the activation of platelet. Activated platelet causes the life span to be shortened, thereby reducing blood levels [11]. Based on previous studies, several types of pathogens capable of causing pneumonia can trigger apoptosis in platelet, where CAP in patients with thrombocytopenia was associated with higher levels of severity and mortality rates [29,30].

In this study, platelet count cut-off value was 152,000 with sensitivity = 0.322, and specificity = 0.919 with AUC value of 0.594 (95%CI=0.511-0.676), at a p-value = 0.029 ($p < 0.05$), showing a significant correlation. AUC value of 0.594 showed that the predictor value of platelet count severity was very weak. This is slightly different from previous study, where the platelet count can be used as a predictor of CAP severity with a platelet count cut-off value of 150,000. However, the subjects were CAP patients with thrombocytopenia, which were further divided into mild, moderate, and severe thrombocytopenia categories, showing the majority in the severe condition [30]. Similar results were also obtained with platelet count cut-off value of 150,000 and AUC value of 0.560, showing that the platelet count was a weak predictor and cannot be used to predict CAP severity [10].

Conclusions and Implications

Community-Acquired Pneumonia (CAP) is a major global health concern, ranking as the third leading cause of death worldwide. It has a particularly devastating effect on mortality rates and sepsis in developing nations. CAP is characterized by inflammation of the lung tissue that is acquired outside of a healthcare facility or hospital setting. Certain groups of individuals, including the elderly, those with weakened immune systems, individuals with underlying health conditions, and those with certain lifestyle factors, are at a higher risk of developing pneumonia. The incidence of this medical condition in the world is estimated to vary between 1.5 and 14 cases/1000 people/year. Based on the 2018 National Basic Health Research of Indonesia, the prevalence of pneumonia according to the diagnosis by health workers, including doctors, midwives, or nurses, is estimated at 2%. In Surakarta, the prevalence of pneumonia based on the diagnosis by health workers is estimated at 1.86%. Pneumonia severity is often assessed using several instruments, particularly Pneumonia Severity Index (PSI). This instrument helps doctors to determine patient treatment options, either outpatient or inpatient. Components contained in PSI are demographic factors, and comorbidities, including physical, laboratory, and radiographic examination with a total of 20 variables. Furthermore, PSI instrument has higher accuracy compared to CURB-65 instrument in assessing the prognosis of CAP patients due to the comprehensive inclusion of variables. The platelet plays a crucial role in the hemostasis process and the body defense against infectious agents. The level of platelet in the blood, namely the platelet count, is measured

through a complete blood count test, serving as a relatively cheap, easily accessible, and routine supportive examination.

According to previous study, the platelet level abnormality is a better predictor of severity and clinical outcomes in community-acquired pneumonia compared to leukocyte level abnormality. Abnormal platelet levels, both thrombocytopenia and thrombocytosis were associated with worse clinical outcomes compared to normal platelet levels in patients with community pneumonia. In the same study, it was mentioned that community pneumonia patients with thrombocytopenia were associated with higher severity based on the CURB-65 instrument compared to patients with normal platelet levels or thrombocytosis. A similar thing was also mentioned in another study, that community pneumonia patients with thrombocytopenia conditions were associated with a more severe degree of severity based on the CURB-65 instrument.

Despite the high prevalence of pneumonia in Indonesia, there is a lack of sufficient information regarding the relationship between the platelet count and the severity of community-acquired pneumonia (CAP) as measured by the PSI score. As a result, this study aimed to investigate the correlation between the platelet count and CAP severity in patients assessed using the PSI score at Dr. Moewardi General Hospital Surakarta.

An analytical observational method with a retrospective cross-sectional design was used in the study. The data used included the results of routine blood tests and CAP severity based on PSI score obtained from medical records of patients at Dr. Moewardi General Hospital Surakarta. The purposive sampling method was used by selecting samples that met the inclusion and exclusion criteria. The inclusion criteria were hospitalised CAP patients, those receiving routine blood tests, and aged over 18 years. The exclusion criteria were patients infected with HIV, having a history of blood disorders such as ITP, leukemia, aplastic anemia, dengue fever, and malaria, those diagnosed with tuberculosis, with incomplete medical record data, and those being confirmed positive for COVID-19.

The variables tested were the platelet count and CAP severity. The platelet count is a laboratory examination carried out to determine the level of platelet in the blood. Subsequently, CAP severity was measured using PSI instrument. In this study, the severity degree was grouped into two, namely classes I, II, and III which were included in the mild degree, while classes IV and V were included in the moderate-severe degree. The Spearman correlation test was used to determine the correlation between platelet count and CAP severity. p-value of <0.05 was considered statistically significant. The logistic regression test was used to determine the correlation between comorbidities contained in PSI and severity degree based on PSI score. A significance value <0.05 showed that comorbidities had a significant correlation with severity degree. The platelet count cut-off value was determined using Receiver Operating Characteristic (ROC) curve, sensitivity, and specificity values.

In this study, a total of 183 subjects participated, and their average age was 56.90 years. The participants had an average platelet count of 272,688.52 (SD $\pm$ 157,524.87). Based on the severity degree assessed using the PSI score, the subjects were divided into two groups. The first group consisted of 87 patients categorised as having a mild degree of severity, while the second group included 96 patients categorised as having a moderate-severe degree of severity. The majority of cases in this study fell into the moderate-severe category, accounting for 52.5% of the total. Several factors, including malignancy, liver disease, cerebrovascular disease, and kidney disease, were found to have a significant correlation with the severity degree, with a significance level of less than 0.05. Notably, kidney disease showed the highest odds ratio (OR) value among these factors.

The platelet count was found to be negatively correlated with CAP severity based on the PSI score at Dr. Moewardi General Hospital Surakarta, with a p-value of 0.029 ($p < 0.05$) and a correlation coefficient of 0.162, indicating a low correlation value. The ROC curve analysis revealed that the platelet count had a very weak predictive value, with an AUC value of 0.594. The optimal cut-off value for the platelet count to predict CAP severity was determined to be 152,000, with a sensitivity of 0.322 and a specificity of 0.91.

In conclusion, although a significant relationship was found between the platelet count and CAP severity based on the PSI score, the platelet count alone is not a reliable predictor of CAP severity. Additional factors and tests should be considered to accurately predict the severity of CAP in patients at Dr. Moewardi General Hospital Surakarta.

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Conflicts of Interest

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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