The Relationship Between SpO_2/FiO_2 Ratio
to Community Acquired Pneumonia Patient Outcomes
at Kolonel Abunjani Bangko General Hospital

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Abstract

Background: Acute lower respiratory tract infection causes high morbidity and mortality, which can be found in the form of pneumonia. Community acquired pneumonia (CAP) severe pneumonia can lead to acute respiratory distress. To diagnose acute respiratory disorders, namely Acute Lung Injury (ALI) and Acute Respiratory Stress Syndrome (ARDS), the ratio PaO_2/FiO_2 is used. This requires invasive action by taking an arterial blood sample, which is expensive and not available in all health facilities. An alternative is pulse oximetry, which measures the SpO_2/FiO_2 ratio and is available in health facilities. It is inexpensive and non-invasive. This study aims to determine the relationship between SpO2 and FiO2 with the outcome of community pneumonia patients at Kolonel Abunjani Bangko Hospital.

Method: The study design was a retrospective descriptive cross-sectional design. The research subjects were a total sampling of medical record data from inpatients with community acquired pneumonia for the period January-December 2022. The study variables included gender, age, SpO_2/FiO_2 ratio, and outcomes of pneumonia patients. Univariate and bivariate statistical tests were used to analyze the data.

Results: In this study, there were 43 subjects who met the inclusion criteria. The distribution of inpatient community acquired pneumonia patients, especially in the gender was mostly male (67.4%), the highest age was 56–65 years and >65 years (both 37.2%), the median SpO_2 was 94% (36-99%), the median SpO_2/FiO_2 ratio was 447 (171-471%), the highest outcomes were alive patients (36 patients). The ratio of SpO_2/FiO_2 >316 was the majority (33 patients). Based on the relationship between the SpO_2/FiO_2 ratio and the outcome of CAP with alive outcome was a SpO_2/FiO_2 ratio >236 was more numerous than SpO_2/FiO_2 ratio <236 with value of P=0.0005.

Conclusion: There is a significant relationship between the SpO_2/FiO_2 ratio and the outcome of community acquired pneumonia patients at Kolonel Abundjani Hospital Bangko.

Keywords: community-acquired pneumonia (CAP), SpO_2/FiO_2 ratio, outcome of community acquired pneumonia

INTRODUCTION

Oxygen is one of the vital elements in the process of metabolism that maintains the viability of all body cells. Normally, oxygen is obtained during the inhalation process. The delivery of oxygen to body tissues is determined by the interaction of the respiratory system. Lack of oxygen is characterized by hypoxia, which, in advanced processes, causes tissue death and can even be life-threatening.[1]

Hypoxemia is a condition in which there is a decrease in the concentration of oxygen in the arteries. The way to find out if there is hypoxemia is to monitor oxygen saturation levels (SpO_2), which can measure how much oxygen concentration (O_2) can be carried by hemoglobin. The normal value of oxygen saturation is 95–100%. Oxygen saturation is important to monitor because it can indicate the adequacy of oxygenation or tissue perfusion in the patient, which will cause failure in oxygen transport because oxygen in the body is bound by hemoglobin and dissolved in blood plasma in small amounts.[1]

Acute lower respiratory tract infections cause high morbidity and mortality, which can be found in the form of pneumonia. Pneumonia can be divided into community-acquired pneumonia (CAP), hospital-acquired pneumonia (HAP), and ventilator-acquired pneumonia (VAP).[2] Community-acquired pneumonia (CAP) is one of the most common infectious diseases and an important cause of mortality and morbidity worldwide. Typical bacterial pathogens that cause CAP include *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarhalis*.[3]

The incidence of CAP varies greatly from country to country. In the United States, CAP is estimated to occur in 248 out of 10,000 adults annually, whereas a Veterans Health Administration study recorded 472.2 cases per 100,000 people in 2017.[4] Influenza and pneumonia combined remain in the top 10 causes of death in the United States. This combination is responsible for 1.6% (53,495) of deaths in 2020.[5]

The incidence of CAP in Malaysia, the Philippines, and Indonesia is the most frequent cause of hospitalization for ages <5 years and >50 years. There are 988 cases of pneumonia per 100,000 people in Indonesia in 2015.[6] Based on data from the Jambi provincial health office's strategic plan for 2015, there was an increase in pneumonia cases, namely 50.6%.[7]

Severe pneumonia can progress to the occurrence of disturbances in the occurrence of acute respiratory distress. Acute respiratory distress is divided into two categories, Acute Lung Injury (ALI) and Acute Respiratory Distress Syndrome (ARDS). This is associated with high mortality and morbidity.[8]

Based on *the* American-European Consensus Conference (AECC) in 1994, the diagnostic criteria for ALI and ARDS are acute onset of disease, chest X-ray showing bilateral pulmonary infiltrates, less significant left ventricular dysfunction, and PaO_2/FiO_2 (PF) ratio <300 ALI and <200 ARDS. The first three components can be

found in the history, physical examination, and support such as an ECG and X-rays. However, the PF ratio criterion requires arterial blood sampling (blood gas analysis).[8]

Taking blood samples for blood gas analysis (BGA) is an invasive procedure. Meanwhile, pulse oximetry, which measures blood oxygen saturation (SpO_2), is the most common technique that can be used to monitor oxygenation in an effective and safe way without any invasive procedures. The SpO_2/FiO_2 ratio is expected to be one of the options for diagnosing ALI and ARDS as a substitute for the invasive PF ratio.[8]

In a study conducted by Emir Festic et al in 2015, it was shown that SpO_2 and FiO_2 are markers of impaired oxygenation at the time of admission to the hospital and a significant predictor of the development of early Acute Respiratory Distress Syndrome and mortality in hospitals. Patients who have a low SpO_2/FiO_2 ratio on admission have a tendency to die earlier than patients with a high SpO_2/FiO_2 ratio upon admission. In addition, it has been shown that SpO_2 and FiO_2 are useful for calculating organ failure scores in the absence of invasive arterial blood gas sampling.[9]

Kolonel Abundjani Bangko Hospital is a Regional General Hospital in Merangin Regency, Jambi Province, and is one of the referral hospitals. Due to limited reagents, an BGA examination could not be performed to diagnose ALI and ARDS at this hospital. One thing that can be done is to use oxygen saturation. Research on the

relationship between SpO_2 and FiO_2 and community acquired pneumonia patient outcomes has never been studied. Therefore, the authors are interested in conducting research on the relationship between SpO_2 and FiO_2 and the outcomes of community acquired pneumonia patients at Kolonel Abunjani Hospital in Bangko.

METHOD

This research is a cross-sectional study with a retrospective design using secondary hospital data, namely medical records of patients treated in integrated rooms for the period January 2022 to December 2022.

The research subjects were all community acquired pneumonia patients who had been treated in the integrated room of the Kolonel Abundjani Hospital in Bangko. The inclusion criteria in this study were all patients diagnosed with CAP based on diagnostic criteria, namely: on the chest X-ray, there was an air bronchogram infiltrate coupled with several symptoms such as cough, body temperature >38ºC, history of fever, changes in the characteristics of purulent sputum, chest pain, and tightness; on physical examination, consolidation was found; bronchial breath sounds and crackles; leukocytes >10,000 or <4,500; treated in the integrated room of Colonel Abundjani Hospital Bangko.

Exclusion criteria for this study were patients not diagnosed with CAP and/or accompanied by other diseases that also affected oxygenation (asthma, Chronic

Obstructive Pulmonary Disease [COPD], bronchiectasis, Congestive Heart Failure [CHF], Chronic Kidney Disease [CKD]) and incomplete study data. The sample collection technique is total sampling.

Preliminary data such as age, sex, oxygen saturation data without being given O$_2$ while in the emergency room, and patient outcomes (alive or dead) were recorded in the data collection sheet. The research data were analyzed statistically with the help of the Windows SPSS (Statistical Product and Science Service) computer program version 25.0.

Analysis and presentation of data using univariate analysis to analyze the characteristics of one variable by conducting descriptive analysis. Distribution of data used frequency and percentage for categorical data, for numeric data used mean±SD if the data is normal or median (min-max) if the data is not normal. Bivariate analysis was used to analyze the relationship between the SpO$_2$/FiO$_2$ ratio and community pneumonia patient outcomes using the Chi-square test. If no two cells have an expected value of less than five, use the Kruskall-Willis test.

RESULTS

Of the 375 patients treated in the integrated room of Colonel Abundjani Bangko General Hospital for the period January 2022–December 2022, 62 were diagnosed with CAP. Of the 62 patients with CAP, 43 met the inclusion criteria and 19 met the exclusion criteria (Table 1).

Table 1. Demographic characteristics of community acquired pneumonia patients (N=43)

Characteristics	N (%)
Gender	
Man	29 (67.4%)
Woman	14 (32.6%)
Output	
Alive	36 (83.7%)
Died	7 (16.3%)
Age	
12-16	1 (2.3%)
17-25	1 (2.3%)
26-35	1 (2.3%)
36-45	2 (4.7%)
46-55	6 (14.0%)
56-65	16 (37.2%)
>65	16 (37.2%)
SpO$_2$% [median (min-max)]	94 (36-99)
SpO$_2$/FiO$_2$ [median (min-max)]	447 (171-471)

Table 1 shows the demographic characteristics of community acquired pneumonia patients who are treated in the integrated room of Kolonel Abunjani Bangko Hospital. Based on gender characteristics, there were 29 men (67.4%) and 14 women (32.6%). Based on the outcomes of community acquired pneumonia patients, it was found that 36 people (83.7%) lived and 7 people died (16.3%). Most of the community acquired pneumonia patients were aged 56–65 years and >65 years, with 16 patients (37.2%). The median SpO$_2$ of patients was 94%; the lowest was 36%, and the highest was 99%. The median SpO$_2$/FiO$_2$ ratio was 447, the lowest was 171, and the highest was 471.

Table 2 shows the analysis of the SpO2/FiO$_2$ ratio. Classified into 3 groups, namely <235, 236-315, and >316. SpO$_2$/FiO$_2$ ratio value <235 by 7 people

(16.3%), SpO_2/FiO_2 ratio value 236-315 by 3 people (7.0%), and SpO_2/FiO_2 ratio value >316 by 33 people (76.6%).

Table 2. Analysis of the SpO_2/FiO_2 ratio

Categories	N	%
<235	7	16.3
236-315	3	7.0
>316	33	76.7

Table 3 shows the relationship between the ratio of SpO_2/FiO_2 and the outcome of community acquired pneumonia. The value of the ratio SpO_2/FiO_2 was 235, and 7 patients died. The SpO_2/FiO_2 ratio value is 236-315, namely 3 people with lived outcomes. $SpO2/FiO2$ ratio >316 in 33 patients with survival outcomes This study found a significant relationship between the SpO_2/FiO_2 ratio and community acquired pneumonia patient outcomes, with value of P=0.0005. This means that the smaller the value of the SpO_2/FiO_2 ratio, the worse the outcome for community acquired pneumonia patients.

Table 3. Relationship between SpO_2/FiO_2 ratio and community pneumonia outcomes

Categories	Outcome				P
	Lived		Died		
<235	0	0.0%	7	100.0%	
236-315	3	100.0%	0	0.0%	0.0005
>316	33	100.0%	0	0.0%	
Total	36	83.7%	7	16.3%	

DISCUSSION

The diagnosis of ARDS should use the value of the ratio between the partial pressure of oxygen and the fraction of oxygen (PaO_2/FiO_2) using arterial blood (AGD). Blood Gas Analysis (AGD) is an invasive procedure, expensive, and not available in all places. In contrast, pulse oximetry is readily available, accurate, inexpensive, and non-invasive. The ratio of oxygen saturation to fraction of oxygen (SpO_2/FiO_2) has been validated in clinical studies for the diagnosis and as an alternative option for assessing the degree of hypoxaemia in ARDS.[10] The use of pulse oximetry as an alternative to assessing the degree of hypoxemia in the diagnosis of ARDS was first introduced in 2007.[11]

Based on the results of this study, it was found that the characteristics of gender were male, with the largest number being 29 people (67.4%) and women being 14 people (32.6%). Based on the outcomes of community acquired pneumonia patients, it was found that 36 people (83.7%) lived and 7 people died (16.3%). Most of the community acquired pneumonia patients were aged 56–65 years and >65 years, with 16 patients (37.2%). The median SpO_2 of patients was 94%; the lowest was 36%, and the highest was 99%. The median SpO_2/FiO_2 ratio was 447, the lowest value was 171, and the highest was 471, while the highest outcome was life, namely 36 patients, and 7 patients died.

This is the same as a study conducted by Fransisko et al, the sample size was 3,606 people. Based on gender, the majority were men (2,122 people) and women (1,484 people). The age 61–75 is the most, which is 992 people. Based on the outcome, 733 people died, 317 people were treated in the ICU, and 2050 people were treated normally.[12] In contrast to the study conducted by Bilan et al, of the 70

children enrolled in this study, 38 were female (54.3%) and 32 were male (45.7%). The mean age of the study population was 32 years and 5 months.[8]

Based on the analysis of the SpO$_2$/FiO$_2$ ratio Classified into 3 groups, namely <235, 236-315, and >316. The value of the SpO$_2$/FiO$_2$ ratio <235 is 7 people (16.3%); The value of the SpO$_2$/FiO$_2$ ratio 236-315 is 3 people (7.0%); and the value of the SpO$_2$/FiO$_2$ ratio > 316 is 33 people (16.3%).

This is the same as according to the Kigali modification, which defines the degree of hypoxic ARDS using the SpO$_2$/FiO$_2$ ratio with an intersection point less than or equal to 315.[13] Rice et al found that PaO$_2$/FiO$_2$ 200 for ARDS and SpO$_2$/FiO$_2$ 315 correlated with the ratio of PaO$_2$/FiO$_2$ 300 for ALI.[11] Slightly different from the study by Bilan et al, they identified 181 cut points for ARDS and 235 for ALI. This cut-off point has a sensitivity of 71% and a specificity of 82% for diagnosing ARDS, and a specificity of 100% and a sensitivity of 57% for diagnosing ALI.[8]

This study obtains a relationship between ratios SpO$_2$/FiO$_2$ and community acquired pneumonia outcome, SpO$_2$/FiO$_2$ value <235. Seven patients died. SpO$_2$/FiO$_2$ ratio values ranged from 236-315 in three patients with survival outcomes. The SpO$_2$/FiO$_2$ ratio value >316 was needed to get 33 patients with survival outcomes. Based on the results of the Kruskal-Wallis test, the value P=0.0005, it means that there is a significant relationship between the SpO$_2$/FiO$_2$ ratio and the outcome of community acquired pneumonia patients at

Kolonel Abundjani Bangko Hospital. This is similar to a study conducted by Lu et al, regarding the SpO$_2$/FiO$_2$ ratio as a non-invasive prognostic marker for intensive care patients with COVID-19. Shows that the SpO$_2$/FiO$_2$ ratio can serve as a marker of 1.82 times the risk of death.[14]

CONCLUSION

From this research it was found that significant relationship between the SpO$_2$/FiO$_2$ ratio and the outcomes of CAP at Kolonel Abundjani Bangko Hospital.

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