Risk Factors of Hypoxemia in Children With Pneumonia

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Risk Factors of Hypoxemia in Children With Pneumonia

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Abstract

Objective To evaluate the risk factors of hypoxemia in children with pneumonia.

Methods A retrospective study was conducted for children aged 2 months until 5 years old with pneumonia who were hospitalized from 2015 to 2016 at Dr. Soetomo Hospital. We evaluated comorbidities as risk factors of hypoxemia in children with pneumonia. Hypoxemia was defined as the arterial partial pressure of oxygen below 80 mmHg recorded from arterial blood gas analysis. We used the chi-square test and logistic regression presented as adjusted odds ratio (OR) and 95% confidence interval (95% CI), two tail test with $p<0.05$.

Result One hundred and ninety-six children with pneumonia enrolled in this study, with 62.2 % were male and 75.5% aged 2-12 months old. Hypoxemia was mostly found in children between 2 until 12 months old (OR 2.012, 95% CI 1.000 to 4.046, $p=0.048$). Univariate analysis revealed sex and almost all comorbidities (malnutrition, down syndrome, neurological disorder, encephalitis, HIV infection, and congenital heart disease) were not risking factors of hypoxemia in children with pneumonia. Logistic regression revealed anemia and severity of pneumonia based on WHO criteria as a risk factor of hypoxemia. Anemia occurred in 89.3% with hypoxemia (adjusted OR 4.984, 95% CI 2.239 to 11.097, $p<0.001$). Hypoxemia occurred in 93.9% of children with severe pneumonia (the OR 6.313, 95% CI 1.418 to 28.106, $p=0.016$).

Conclusion Anemia and severity of pneumonia were risk factors of hypoxemia in children with pneumonia, aged 2 months until 5 years old.

Keywords**:** *children with pneumonia, hypoxemia, risk factor, arterial blood gas analysis, severe pneumonia*

Introduction

Pneumonia is a leading killer of children. More than 2 million children under 5 years old die from pneumonia each year, almost 20% of under 5 deaths worldwide.[1] In 2010, there were almost 4 million new cases of pneumonia in children 0-4 years old in Indonesia. 11.5% of cases were severe and 4.2% severe cases led to death.[2] The etiology of pneumonia can be viral or bacterial. A cohort study in two hospitals in Semarang, Indonesia was found the most common causative agents were Influenza virus (18%), *Klebsiella pneumoniae* (14%), and *Streptococcus pneumoniae* (13%).[3] A study found that age under 4 months or hypoxia (oxygen saturation < 85 percent) were risk factors for mortality in children with pneumonia. The children who had either of the risk factors were 5.6 times more likely to die than children without the factors.[4] To reduce mortality, predictive factors need to be addressed with more attention. Since the decrease in oxygen saturation is an important factor, this research is aimed to find risk factors of hypoxemia in children with pneumonia.

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Materials and Method

A retrospective study was performed at the pediatric ward at Dr. Soetomo Hospital. The subjects were children aged 2 months until 5 years old hospitalized

with pneumonia from January 2015 until December 2016. Pneumonia was defined by WHO criteria fast breathing of at least 50 breaths per minute in a child aged 2-11 months and at least 40 breaths per minute in a child aged 1-5 years and also chest indrawing.

Age, gender, and clinical presentations were recorded. The severity of pneumonia was based on WHO criteria which are a cough or difficulty breathing with at least oxygen saturation below 90% or severe respiratory distress or one of the danger sign (inability to drink, reduced level of consciousness, convulsions). Comorbidities as risk factors of hypoxemia were evaluated from clinical, laboratory and radiology data. Complete blood count and blood-gas analysis were performed on admission. Hypoxemia was defined as the arterial partial pressure of oxygen below 80 mmHg recorded from arterial blood gas analysis.

Chi-square test and logistic regression were performed using SPSS. Adjusted odds ratio (OR) were presented using 95% confidence interval and two-tail test. *P*-value of <0.05 was considered significant. This study was approved by The Ethical Committee of Faculty of Medicine Universitas Airlangga – Dr. Soetomo Hospital.

Results

196 patients were enrolled in this study. Patients' age ranged from 2-56 months, with 75.5% being 2-12 months old. 62.2 % of patients were male (Table 1). Apparently, hypoxemia was very common from our patients. From all the pneumonia patients, 144 children (73.5%) had hypoxemia from the blood gas analysis. We found that mostly hypoxemic patients were in the age group 2-12 months old.

We analyzed several comorbidities in the subjects (Table 2). Comorbidities were common among the patients. Most patients with comorbidities were more likely to have hypoxemia, except malnutrition and congenital heart disease. From univariate analysis using chi-square, anemia (OR 5.193; 95% CI 2.358-11.43) and severe pneumonia (OR 6.858; 95% CI 1.580-29.77) were significant risk factors for hypoxemia.

The risk factors significant during univariate analysis were entered into a multivariate model using logistic regression. We found that anemia (adjusted OR 4.984; 95% CI 2.239-11.097) and severe pneumonia (adjusted OR 6.313; 95% CI 1.418-28.106) continued to be associated with hypoxemia (Table 3).

Anemia occurred in 84 patients (42,9%). 89.3% children with anemia had hypoxemia. Most children (41.8%) had moderate anemia (Hb=7-10). 20.4% patients had mild anemia, while only 1.5% patients had severe anemia (Hb<7). Severe pneumonia occurred in 33 patients (16.8%), yet 93.9% of them had hypoxemia.

Discussion

Most of the patients were in the age range of 2-12 months old. This result was similar to a 2009 study in Taiwan where children aged younger than 1-year-old had the highest incidence of pneumonia.[5] The hypothesis was that in this age group, viral etiology is greater. However, pneumococcal/lobar pneumonia was greater in children aged 2-5 years old, due to higher pneumococcus colonization rate in kindergarteners. Another study also found that community-acquired pneumonia was higher in children aged under 2 years than in those aged 2-6 years.[6] Almost two-thirds of our patients were male. Some studies also had more male child with pneumonia than female, usually around 60% male and the rest female.[7,8]

Malnourished children in our study were less likely to have hypoxemia than children without malnutrition. This finding was different from what a study in Bangladesh which found more children with hypoxemia had malnutrition, although it was not significantly related.[9] The case fatality rate, however, was still higher in malnourished children due to late recognition of pneumonia, immunodeficiency, comorbidities such as diarrhea, and delayed health-seeking behavior.

From our finding, children with Down syndrome, neurological disorder, and encephalitis was more vulnerable to hypoxemia, even though they were not significantly related. Children with neurologic disorder such as cerebral palsy, developmental delay, Down syndrome, epilepsy, and other diseases were more commonly hypoxic than children with other non-neurological underlying conditions or without underlying conditions. Children with neurological disorders also were more likely to be admitted to ICU.[10]

Hypoxemia occurred in all of the patients with HIV infection, but HIV status was not significantly related to hypoxemia. HIV exposed children had higher rates of treatment failure and in-hospital mortality than HIV-unexposed children. But, the same study found no

significant differences in hypoxia and WHO disease severity by HIV exposure status.[11]

34.2% of the children in this study had congenital heart disease (CHD). However, the proportions of hypoxemia were higher in children without CHD. The prevalence of CHD was higher than a study in Nigeria with the prevalence of 11.6%.[12]

We found that anemia was a significant risk factor for hypoxemia. A study found that anemic children were four times more susceptible to develop pneumonia compared with non-anemic children.[13] Anemia caused erythrocytes' inability to provide adequate oxygen to the body's tissues.[14]

Furthermore, iron deficiency made it easier to contract acute lower respiratory tract infection. Alveolar macrophages may be difficult to obtain iron from red blood cell metabolism in iron deficiency states.[15]

One study found that cyanosis was higher in children with iron deficiency anemia.[16] Anemia also was associated with severe acute lower respiratory infection in another study.[17] It is reasonable that early and accurate diagnosis of iron deficiency anemia in children and supplementation iron can reduce the incidence and severity of pneumonia in children.

Severe pneumonia also was significantly related to hypoxemia. This consolidated that blood oxygenation remained an essential factor for evaluating pneumonia severity and need for hospitalization. Risk of death in children with hypoxemia was 1.4 to 4.6 times higher than in those without hypoxemia.[18] Oxygen administration is essential in treating severe pneumonia, with the recommendation of giving by nasal cannulae.

Conclusion

From the multivariate analysis, we found anemia (adjusted OR 4.984; 95% CI 2.239-11.097) and severity of pneumonia (adjusted OR 6.313; 95% CI 1.418-28.106) were risk factors of hypoxemia in children with pneumonia, aged 2 months until 5 years old. Early diagnosis and management of risk factors associated with hypoxemia can help reduce mortality in cases of pneumonia in children.

Table 1. Characteristic of Pneumonia Patients at Pediatric Ward of Dr. Soetomo Hospital from January 2015-December 2016

Comorbidities	Patients n (%)	Hypoxemia proportions in children with comorbidity	Hypoxemia proportions in children without comorbidity	OR (95% CI)	p
Malnutrition	83 (42.3)	71.1	75.2	0.810 (0.428-1.533)	0.517
Down syndrome	13 (6.63)	84.6	72.7	2.068 (0.443-9.658)	0.346
Neurological disorder	26 (13.3)	76.9	72.9	1.237 (0.467-3.272)	0.668
Encephalitis	7 (3.6)	85.7	73	2.217 (0.261-18.87)	0.455
HIV infection	5 (2.6)	100	72.8	1.374 (1.260-1.499)	0.173
Congenital heart disease	67 (34.2)	70.2	75.2	0.775 (0.401-1.498)	0.448
Anemia	84 (42.9)	89.3	61.6	5.193 (2.358-11.43)	0.000
Severe pneumonia	33 (16.9)	93.9	69.3	6.858 (1.580-29.77)	0.003

Table 2. Univariate Analysis of Comorbidities in Pneumonia Patients at Pediatric Ward of Dr. Soetomo Hospital from January 2015-December 2016

Table 3. Multivariate Analysis of Risk Factors for Hypoxemia

Risk factors	Adjusted OR (95% CI)	p
Anemia	4.984 (2.239-11.097)	<0.001
Severe pneumonia	6.313 (1.418-28.106)	0.016

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Conflict of Interest : -

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