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Original Article

Mortality predictors of pneumonia in children

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Abstract

Background Pneumonia is one of the main causes of death in children in developing countries. It is important to identify clinical signs, demographic factors, and laboratory data which can be used to predict children who have higher risk of mortality from pneumonia.

Objective To find the clinical signs, demographic factors and laboratory data that can be used as predictors of mortality from pneumonia.

Methods This historical case-control study was carried out in Sardjito Hospital between January 2004 and December 2006. Data were obtained from medical records. Differential proportion between groups was analyzed with chi square. Regression analysis was used to identify clinical factors, demographic factors and laboratory factors that associated with mortality from pneumonia.

Results Fifty-eight patients were enrolled in this study, 29 patients were dead (case group) and 29 patients were cured (control group). Baseline data between the two groups were similar in terms of gender and mean of age. Bivariate analyses show that the predictors of mortality in children with pneumonia were: age < 1 year (OR 3.11, 95% CI 1.06 to 9.08), malnutrition (OR 7.30, 95% CI 1.62- to 21.03), age of the mother < 20 years (OR 2.21, 95% CI 1.64 to 2.97), tachycardia (OR 6.075, 95% CI 1.18 to 31.24), and anemia (OR 5.83, 95% CI 1.88 to 18.10). Logistic regression analysis shows that tachycardia (OR 6.04, 95% CI 1.01 to 36.17) and anemia (OR 4.41, 95% CI 1.25 to 15.51) were predictor of mortality in children with pneumonia.

Conclusions Tachycardia and anemia play as independent mortality predictors of pneumonia in children. **[Paediatr Indones. 2010;50:149-53]**.

Keywords: *pneumonia, child, mortality predictor*

Pneumonia is still a major problem in the world, particularly in developing countries. Almost 15 million children die annually around the world due to pneumonia, and two thirds of these children were less than 1 year old; 95% of them came from developing countries.[1] Pneumonia is the cause of 4 millions of death among children.[1-3] Pneumonia is responsible for one third of death among children.[4] A study in Zambia showed that pneumonia is the main reason of death and the second leading cause of morbidity among children < 5 years aged. Data from 1992 indicated that the mortality rate due to pneumonia in Kalabo Hospital in Zambia is between 10% and 15%.[5]

Studies in the United States suggested that the mortality rate due to pneumonia fell down to 97% from 1939 to 1996 (from 24.637 in 1939 to 800 in 1996). This decline was significant on year 1944 – 1950, which could be explained by the use of penicillin. The decrease of mortality rate at nearly 13% annually on all categories of age occurred from 1966 to 1982.[2]

In Indonesia, the results of health survey on the households (*Survei Kesehatan Rumah Tangga* / SKRT) in 1980, indicated that 19.9% cause of death in the

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population was acute lower respiratory infections. These infections are the cause of death in 22.1% infants aged 0 - 1 year old and 28.2% of children aged 1 - 5 years. The same survey in 2001 found that mortality of infants due to pneumonia among 5 per 1000 infants per year. It means that pneumonia was the cause of death of more than 100.000 infants every year or nearly 300 infants every day or 1 infant every 5 minutes.[6] In Sardjito Hospital Yogyakarta, pneumonia was the major disease causing hospitalization in pediatric respirology division in 2004 (48.7%) and 2005 (48.1%). According to the annual report of Sardjito Hospital in 2006, pneumonia ranked the seventh (bronchopneumonia, 2.5%) and ninth (aspiration pneumonia, 1.4%) of pediatric out-patient diagnosis in 2005.

The high rates of morbidity and mortality due to acute respiratory infections in Indonesia should be investigated. Indonesian Ministry of Health has committed to reduce the morbidity and mortality caused by acute respiratory infections, especially among infants and children under 5 years.[7] Studies on the factors related to death caused by pneumonia yield varied results.[8-13] Such studies are very limited in Indonesia. This study aimed to find out clinical, demographic, and laboratory factors that influenced mortality due to pneumonia in children treated at Sardjito Hospital in Yogyakarta.

Methods

This was a retrospective case-control study.[14] All children diagnosed with pneumonia and treated at the Child Health Division of Sardjito Hospital Yogyakarta from January 2004 until December 2006 were enrolled this study. We excluded patients with congenital heart disease, central nervous system infections, frequent episodes of asthma, anatomical disorders of the respiratory tract, Down syndrome, malignancy, immune incompetence, and those with incomplete data. The diagnosis of pneumonia was based on ICD X (bronchopneumonia (J 18.0), aspiration pneumonia (J 69.0), and lobar pneumonia (J 18.1)).

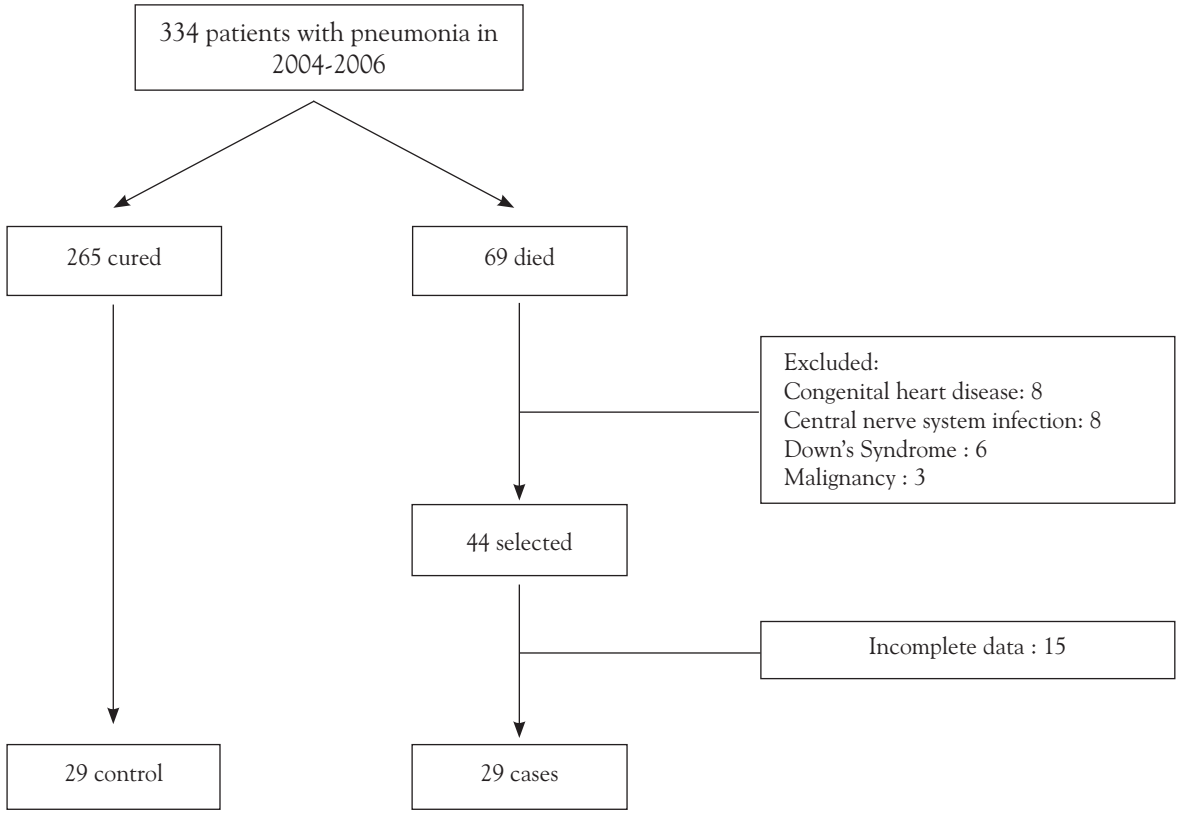

Figure 1. Flow of data collection

The sample size of this study was determined by assumption that malnutrition was predictor of death caused by pneumonia with odds ratio of 3.2,[7] the level of significance was 0.05% and power of 80%; 27 children per group were needed. Therefore, this study required minimum sample size of 54 children.[14] The proportion difference of the two groups was analyzed using chi square. Multivariate analysis using logistic regression method was used to find out the most appropriate and simple model which was able to describe the relationships between the dependent and the independent variables. The level of significance was expressed at 95% confidence interval.

Results

This study was carried out for 4 months from March to June 2007 at Sardjito Hospital Yogyakarta. Data were obtained from the medical records of children under 14 years old treated at Sardjito Hospital due to pneumonia from January 2004 to December 2006. In 2004, 22 of 100 pneumonia patients died (22%), while in 2005 and 2006, 25.8% (24 of 93) and 16% (23 of 141) patients died, respectively.

The basic characteristics of our study, as indicated in **Table 1**, are that the proportion of gender and average age of the two groups were equal. Other basic characteristics are included in the variables that we analyze.

Table 2 shows results of univariate analysis; the mortality significant predictors for children with pneumonia include age <1 year, poor nutrition, mother's age < 20 years, tachycardia, and anemia. Those significant results are then analyzed with multivariate analysis using logistic regression method, and its results are shown in **Table 3**.

In **Table 3**, the significant results of multivariate analysis using logistic regression method as the independent variables of mortality predictors on pneumonia are tachycardia with OR 6.038 (CI 95% 1.008 to 36.169) and anemia with OR 4.406 (CI 95% 1.252 to 15.509).

Table 1. Basic characteristics of study

Characteristics	Total (%)	Died	Cured
Gender:			
- boy	34 (55%)	16	16
- girl	24 (45%)	13	13
Age, mean (SD) months	16.1 (2.49)	15.38 (4.16)	16.88 (2.81)
- < 1 year	30 (52%)	19	11
- ≥ 1 year	28 (48%)	10	18
Nutritional state:			
- normal	40 (69%)	15	25
- undernourished	11 (19%)	8	3
- malnourish	7 (12 %)	6	1
Mother's age :			
- < 20 years	5 (9%)	5	0
- ≥ 20 years	53 (91%)	24	29
Father's age :			
- < 25 years	11 (19%)	8	3
- ≥ 25 years	47 (81%)	21	26
Mother's education :			
- Elementary	7 (12%)	5	2
- Primary High School	7 (12%)	2	5
- Senior High School	35 (60%)	19	16
- University	9 (16%)	3	6
Father's education :			
- Elementary	3 (5%)	2	1
- Primary High School	9 (16%)	6	3
- Senior High School	34 (59%)	18	16
- University	12 (21%)	3	9
Haemoglobin level (mean (SD) g/dL)	10.94 (0.23)	9.96 (0.24)	11.92 (0.28)

* Mean difference: -1.45 (95% CI -11.50 to 8.61) with P= 0.774

Table 2. Mortality predictors on pneumonia incidences using bivariate dichotomy

Variables	Died	Cured	OR	95% CI	P
Age:					
- < 1 year	19	11	3.109	1.064 to 9.081	0.036
- ≥ 1 year	10	18			
Malnutrition:					
- Yes	6	1	7.304	1.618 to 21.030	0.044
- No	23	28			
Mother's age					
- < 20 years	5	0	2.208	1.643 to 2.969	0.019
- ≥ 20 years	24	29			
Father's age					
- < 25 years	8	3	3.302	0.777 to 14.021	0.094
- ≥ 25years	21	26			
Mother's education :					
- Elementary and Primary High School	7	7	1.000	0.300 to 3.330	1.000
- Senior High School and University	22	22			
Father's education :					0.195
- Elementary and Primary High School	8	4	2.381	0.628 to 9.030	
- Senior High School and University	21	25			
Tachypnea :					
- Yes	19	17	1.341	0.463 to 3.887	0.588
- No	10	12			
Tachycardia :					
- Yes	9	2	6.075	1.181 to 31.244	0.019
- No	20	27			
Anemia :					
- Yes	21	9	5.833	1.880 to 18.099	0.02
- No	8	20			

Table 3. Mortality predictors on pneumonia with multivariate analysis

Variables	Death	Cured	OR	95% CI	P
Age:					
- < 1 year	19	11	2.831	0.790 to 10.145	0.110
- ≥ 1 year	10	18			
Tachycardia :					
- Yes	9	2	6.038	1.008 to 36.169	0.049
- No	20	27			
Malnutrition :					
- Yes	6	1	3.805	0.392 to 36.947	0.249
- No	23	28			
Anemia :					
- Yes	21	9	4.406	1.252 to 15.509	0.021
- No	8	20			

Discussion

The case fatality rates among children with pneumonia at Sardjito Hospital from 2004 to 2006 were 22%, 25.8%, and 16% respectively. These figures are still within the range of death rate due to pneumonia reported by WHO in 2005 for Indonesia, i.e., between 25 to 30%. Since the Sardjito Hospital is a referral hospital for Yogyakarta and surrounding area, it is possible that our patients came from those area.

On univariate analysis, the mortality predictors among the children with pneumonia which were statistically significant included patient's age, poor nutrition, mother's age, the presence of tachycardia, and anemia. These results are similar with previous studies.[10,13] This can be explained by the fact that children of age <1 year are relatively having narrower respiratory tracts and the presence of inflammation like pneumonia on a large area magnify the risk for respiratory tract obstruction causing higher risk for hypoxia. It is closely related to the growing risk of death among the children <1 year.

Poor nutrition as a death predictor has mentioned in some previous studies.[9-12] It is suggested that malnutrition create an imbalance production of antibody, i.e., decreasing of lymphocytes, complement production, immunoglobulin A, interferon, T cells, and interleukin receptors.[18] Such conditions influence general body response against infections, causing higher risk of suffering more severe diseases and higher mortality risk. Poor nutrition also causes reduction of protein so that the administered antibiotics do not have maximum effects.

A study by Suwanjutha et al[12] carried out in Thailand mentioned that father's age influenced the outcome of pneumonia, while our study pointed to the mother's age. Maybe this due to that our study used a different cut point for age because in Indonesia marriage limits of age was 20 years old. Age of parents influence the maturity of thinking and decision making process in the family, in which inappropriate decisions can cause delays in treatment for patients with the results of higher risk of death. Many other factors can influence the decision making process such as economical and social status, educational background, socio-cultural, etc. In our study, there were no evidence that parent's educational background is a mortality predictor, while economical and social status was not include as one of the variables in our study.

Unlike the results of study by Ivijanthi et al[13], our study shows that tachycardia is a significant death predictor. However, we are not certain whether it is influenced by higher cases of hypoxia in our subjects because not all patients in our study have their blood gas analyzed to confirm hypoxia although several previous studies have mentioned tachycardia as a good predictor to determine hypoxia condition among the patients with respiratory infections.[15-17]

Anemia as a mortality predictor is consistent with the finding of study by Ivijanthi et. al.[13] It is probably related to the function of hemoglobin to transport the oxygen in which anemia patients have hemoglobin lower than the normal value so that it reduces the function to transport oxygen among children with anemia. Also, the presence of pneumonia that causes hypoxia will make the anemia of the pneumonia patient worsen the hypoxia condition and lead to higher risk of death.

Under this study, no analysis is made on the class of patient treatment. It is considered that, in all classes of treatment, patients receive equal services so that the classes of treatment do not serve as distracting factor in this study. The limitations of this study include its retrospective design and several subjective parameters (such as assessment of tachycardia and tachypnea) that are difficult to be controlled. Therefore, future studies with better methodologies are necessary.

We conclude that tachycardia and anemia are independent mortality predictors for pneumonia in children. In clinical setting, however, age less than

1 year and poor nutritional status may indicate the severity of the disease. The occurrence of hypoxia must be immediately observed if the pneumonia patient of <1 year develops tachycardia and anemia so that an adequate oxygenation will be provided at once. Further studies are necessary to find out the levels of tachycardia and anemia can be good predictors for mortality due to pneumonia among the children.

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