

Original Article

Correlation between nosocomial pneumonia and ventilated patients in pediatric intensive care unit

Cahya Dewi, Purnomo Suryantoro, Roni Naning

Abstract

Background NP (NP) especially VAP (ventilator-associated pneumonia) is the most common infection in intensive care unit, which correlates with the increasing of morbidity and mortality. There are some risk factors for development of NP; the most important one is duration of mechanical ventilator and reintubation.

Objective To determine the correlation between NP and use of mechanical ventilator in pediatric intensive care unit (PICU).

Methods A matched case control study was conducted at Dr. Sardjito Hospital on all patients admitted to the PICU from 2004 until 2006. Case group was defined as all patients who had NP; age and sex matched control group included all patients not diagnosed as NP. Statistical analysis was done by using chi-square and t-tests as appropriate. Logistic regression analysis was done to determine the role of risk factors.

Results One-hundred and forty-one patients were included in this study. The incidence of NP was 25.7%. There was association between using mechanical ventilator (OR 1.08; 95%CI 1.07; 8.20, P=0.036) and duration of using mechanical ventilator more than four days (OR 1.75, 95%CI 1.87;18.02) with development of NP. There was a significant difference in event free survival of NP between those using mechanical ventilator group and those not using mechanical ventilator group (P<0.001).

Conclusion There is an association between the use of mechanical ventilator and duration of use of mechanical ventilator more than four days with the development of NP [Paediatr Indones 2008;48:170-4].

Keywords: NP, child, intensive care, risk factor, case control

Nosocomial infection is the most leading cause for morbidity and mortality in patients in pediatric intensive care unit (PICU). The mortality rate of nosocomial infection in PICU was 11%.¹ According to Myrianthes *et al*² NP (NP) is the most common nosocomial infection that occurs in hospital (27%), followed by urinary tract infection (31%).

Ventilator-associated pneumonia (VAP) is the commonest complication (47%) in the intensive care unit. According to Myrianthes *et al*² VAP is defined as pneumonia in patients with tracheostomy or endotracheal intubation with pneumonia symptoms minimum 48 hours after using ventilator. VAP is also defined as pneumonia in the patients with ventilator which has not yet occurred during intubation.

The incidence of VAP ranged from 6 to 52 cases every 100 patients with regards to the study population. According to a study of NNIS (National Nosocomial Infection),¹ the incidence varies from 5 cases every 1000 ventilator days in children to 35

From the Department of Child Health, Medical School, Gadjah Mada University, Yogyakarta, Indonesia.

Reprint request to: Cahya Dewi, MD, Department of Child Health, Medical School, Gadjah Mada University, Dr. Sardjito Hospital, Jl. Kesehatan No.1, Sekip Utara, Yogyakarta 55281, Indonesia. Tel. 62-274-561616. Fax. 62-274-583745.

cases every 1000 days in patients with trauma. The average number of cases was 10-15 cases every 1000 ventilator-days in patients who hospitalized in ICU. The incidence of pneumonia in ICU is very high, i. e., about 9-24% 48 hours or more after using mechanical ventilator.²

Data of epidemiology and risk factors and outcome of NP occurrence in PICU patients have been very limited. Therefore this study aimed to determine the risk factors that cause NP and particularly to determine the correlation between the use of mechanical ventilator and occurrence of NP. It also determines the outcomes of NP occurrence especially in PICU patients.

Methods

This was a matched case-control study. All hospitalized patients in PICU at Dr. Sardjito Hospital during the period of 2004-2006 diagnosed of having NP criteria based on clinical manifestations and radiology were included in the case group. The control group comprised gender matched patients who had no NP and hospitalized in PICU.

With an assumed important odds ratio of 3, type I error of 5% and power of 80% and case to control ratio of 1 : 2, 47 cases and 94 controls were recruited. The potential risk factors included age, gender, coma, acute respiratory distress (ARDS), use of nasogastric tube (NGT), therapy of stress ulcer, use of mechanical ventilator (MV), duration of using mechanical ventilator and length of stay in PICU.

We defined NP was patient who suffered from pneumonia after 48 hours or more during hospitalization and proven by chest x - ray as having new and persistent infiltrate. Hence, the diagnosis of NP was established based on clinical manifestations and radiology.

Data were analyzed by SPSS 11. Data in numeric scale was analyzed by t-test whereas nominal scale data were analyzed by chi square test. Categorical independent variable to identify the risk factor in the occurrence of NP analyzed using Odds Ratio (OR) and their 95% confidence interval. Logistic regression was performed to determine the independent risk factors for the occurrence of NP.

Results

From January 2004 until January 2006, 626 patients were admitted to the PICU of Dr. Sardjito Hospital, 194 patients (30.9%) were diagnosed as pneumonia and 50 patients (25.7%) fulfilled the criteria of NP diagnosis. Out of the 50 patients, 47 (94%) were included in the case group whereas 94 patients were diagnosed as non-NP and included in the control group. Proportion of case group to control group was 1:2 with matching gender. Hence, the total sample of this study was 141 patients.

The basic characteristics of the subjects are described in **Table 1**. In case group, 26 patients were male (55%); in the control group similar figures were observed.

Death in pneumonia occurred in 19 patients (40%) whereas the surviving patients were 16 (34%). The other 12 patients were discharged upon their own request. Most of the patients in pneumonia group were using mechanical ventilator (78%), yet only 31% patients in non-pneumonia group were using ventilator. The use of ventilator for more than 4 days was observed in pneumonia group more frequent than in non-pneumonia group. The length of stay in PICU of less than one week was discovered mostly in

Table 1. Basic characteristics of the study subjects

	NP n (%)	Non NP N (%)
Age		
< 5 age	40 (85)	63 (67)
≥ 5 age	7 (15)	31 (33)
Gender		
Male	26 (55)	53 (56)
Female	21 (45)	41 (44)
Outcome:		
a. Death	19 (40)	40 (43)
b. Live	16 (34)	9 (10)
c. DAMA*	12 (25.6)	45 (48)
Using Ventilator		
Yes	37 (79)	29 (31)
No	10 (21)	65 (69)
Duration of ventilator		
> 4 days	25 (68)	6 (21)
≤ 4 days	12 (32)	23 (79)
LOS at PICU		
> 1 weeks	15 (32)	16 (17)
≤ 1 weeks	32 (68)	78 (83)

Note:

*DAMA: Discharged Against Medical Advice

* LOS = Length of stay

non-pneumonia group.

We assumed that several risk factors influenced the occurrence of NP (Table 2). Risk factors affecting significantly the occurrence of NP were the use of mechanical ventilator (OR 8.3; 95%CI 3.6;18.9), ARDS condition (OR 4.9; 95%CI 1.9; 12.2), age five or less (OR 5.6; 95%CI 1.0;4.3), use of mechanical ventilator for more than four days (OR 7.9; 95%CI 1.4; 3.8) and length of stay in PICU for more than one week (OR 3.9; 95%CI 1.66; 1.04).

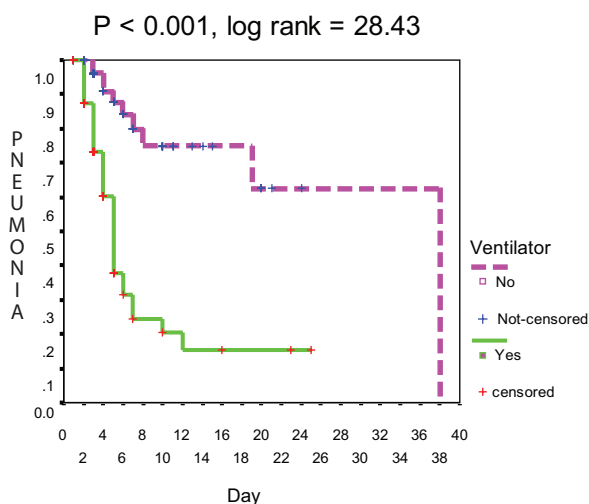


Table 2. Risk factors of NP

	NP (n)	Non NP (n)	OR	95% CI	P
Mechanical Ventilator	37	29	8.3	3.6; 18.9	<0.05*
Reintubation	20	26	1.9	0.9; 4.0	0.075
NGT	44	87	1.0	0.2; 4.2	1.0
Coma	28	45	1.6	0.8; 3.1	0.28
ARDS	16	9	4.9	1.9; 12.2	0.001*
Therapy of stress ulcer	11	27	0.7	0.3; 1.7	0.64
Age <5 years	40	63	5.58	1.0; 4.3	0.017*
Duration of ventilator > 4 days	25	6	7.98	1.44; 3.84	<0.05*
LOS PICU > 1 weeks	15	16	3.9	1.04; 1.66	0.038*

ARDS = Acute respiratory distress syndrome; LOS = length of stay; NGT = nasogastric tube

Table 3. Regression logistic analysis of risk factors of NP

	OR	95%CI	P
Ventilator	1.1	1.07; 8.20	0.036*
ARDS	0.9	0.90; 8.00	0.076
Age < 5 year	0.8	0.71; 6.79	0.171
LOS PICU > 1 weeks	0.3	0.45; 4.05	0.594
Duration of ventilator > 4 days	1.8	1.87; 18.04	0.002*

Table 3 shows the result of logistic regression; the independent risk factors were the use of mechanical ventilation (OR 1.1; 95%CI 1.077; 8.2, P 0.036) and the duration of the use of ventilator for more than four days (OR 1.8, 95%CI 1.87; 18.03). The risk factors of patients under age five, ADRS, and length of stay in PICU for more than a week, statistically did not have any significant difference (P>0.05).

From the graph, we could see the number of patients surviving pneumonia in group without using MV was greater than those with MV. On average, there were significant difference between the surviving group with using MV and those without using MV (P<0.001).

Discussion

The incidence of NP in this study was 25.7%; this agrees with Myrianthes *et al*² which stated that NP was the second most common nosocomial infection (27%) in ICU. According to the study by EPIC3 (European Prevalence of Infection in Intensive Care), of all nosocomial infections, 47% was NP. According to the surveillance data from NNIS (National Nosocomial Infections in ICU),¹ of all nosocomial infections in

ICU, 31% was NP. In contrast, according to Elward *et al*⁴ in a study conducted by a group of multicenters in Europe, the incidence of nosocomial infection in 20 ICUs was 23.6% and infection that occurred most frequently was NP (53%) showing higher incidence than that of current study.

The proportion of male patients suffering from NP was higher than female patients (55% vs. 45%); this was consistent with previous study.⁴ The incidence of NP possibly related to age wherein about five patients of NP in every 1,000 inpatients at younger age and 15 patients of NP in every 1,000 patients at age 65.2 In this research, patients under age five in both groups of NP and non-NP were greater than patients at age five or above. That NP mostly occurred in patients at age five and above became the most likely for the cause.

Death as outcome in group of NP or non-NP in this study showed similar proportion that agrees with Fagon *et al*⁵ statement that of several cohort studies conducted on the death of patients with NP, there was not any significant difference compared to those with non NP (30.5% vs. 30.4%). This showed that the increase of mortality rate was caused by several factors: age, onset of infection occurrence, complexity of primary illness and the degree of severity of pneumonia.

According to Myrianthes *et al*² incidence of NP could increase by the use of mechanical ventilator (increasing 1.6 times higher than that without using MV). In this study, most of patients in group of NP used mechanical ventilator (78.7%). Chastre *et al*⁶ stated that the use of MV would increase the occurrence of NP as much as 3 times or more compared to patients without using MV. Still another study by Martin *et al*⁷ stated that patients using MV increased NP 10 times greater than patients without invasive tools. Based on this study we proved that the use of MV would increase the occurrence of NP 1.08 times greater than that without using MV.

According to Myrianthes *et al*² the duration of using MV also increased the incidence of NP (almost 69% patients on the 30th day compared to 5% on the 5th day of using MV). Therefore, we concluded that incidence of NP would increase significantly along with the duration of using MV. Fagon *et al*⁵ stated that the longer the use of MV (>48 hours), the stronger the factor influencing the occurrence of NP. The oc-

currence of NP or VAP compared to the early onset (occurred within 4 days after using MV) and later onset (occurred after 4 days of using MV) revealed that the early onset of NP showed light symptoms with better prognosis than the late onset.

In this study, the duration of using MV more than four days which increased the occurrence of NP 1.75 times. This was significantly different compared to the duration of using MV less than four days which also caused NP (OR 1.75, 95% CI 1.872;18.028). Elward *et al*⁴ in a study conducted by a group of multicenters in Europe in showed that a patient with nosocomial infection had an average longer length of stay in ICU (26.1 ± 17.3 vs. 10.6 ± 6 days; $P < .001$). They also showed that the average of LOS in PICU in pneumonia patients caused by the use of ventilator was 5.34 ± 13.82 days.

Myrianthes *et al*² stated that incidence of NP would increase along with increment of the duration of stay (LOS) in ICU (1.5 times on the second week of hospitalization). This study resulted in greater number of the patients with more than a week LOS in PICU than those in non NP group. Since multivariate analysis showed that more than a week LOS in PICU was not significantly different, therefore we concluded that it was not the risk factor of NP occurrence.

According to the logistic regression analysis, we concluded that the risk factors which were significant to the occurrence of NP were the use of MV (OR 1.09; 95%CI 1.077;8.2, $P=0.036$) and the length of use of ventilator of more than four days (OR 1.76, 95%CI 1.9;18.0). While the result of survival analysis showed that the number of patients surviving pneumonia on group without using MV was better than those who used MV.

However, there were several weaknesses in this study. We should conduct in a prospective study in order to get a more complete and accurate data, causative relation as well as to avoid biased information. This study was conducted retrospectively with limited and number of cases. Other constraint was establishing the diagnosis of NP.

This study used clinical and laboratorial criteria, but unfortunately the microbiological test of sputum culture was not performed because the test was not conducted regularly. If the design of this study was cohort prospective, it would be possible to conduct microbiological test of sputum culture so that es-

establishing diagnosis as NP would be more accurate. Besides, there were several risk factors serving as variables which information could not be retrieved retrospectively (for example the position of head, suction frequency, and transport patient).

We conclude that the use of mechanical ventilator for more than four days increases the occurrence of neonatal pneumonia in pediatric intensive care unit.

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