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Original Article

Chest x-ray findings and outcomes of children with suspected ventilator-associated pneumonia

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Abstract

Background Ventilator-associated pneumonia (VAP) is a nosocomial infection in patients who have received mechanical ventilation (MV), either by endotracheal intubation or tracheostomy, for more than 48 hours. VAP represents 80% of all hospital-acquired pneumonias. VAP incidence varies from 5.1%-33.3%. The modified clinical pulmonary infection score is a criteria for diagnosing suspected VAP and typically includes radiographic evidence. VAP is associated with significant morbidity and mortality.

Objective To determine the relationship between chest x-ray findings and outcomes in children with suspected VAP.

Methods This retrospective study was held in Dr. Kariadi Hospital from January – December 2010. Data was collected from medical records of pediatric ICU (PICU) patients with suspected VAP. Chest x-ray findings and patient outcomes were recorded. X-ray findings were assessed by the on-duty radiologist. Chi square test was used for statistical analysis.

Results Subjects were 30 children consisting of 14 males and 16 females. Patient outcomes were 23 patients survived and 7 patients died. Chest x-ray findings were categorized into the following groups and compared to patient survivability: diffuse infiltrates 76.7% (OR=0.694; P=0.532; 95% CI 0.102 to 4.717), localized infiltrates 13.3% (OR=4.200; P= 0.225; 95% CI 0.470 to 37.49), and no infiltrates 10% (OR=1.222; P= 0.436; 95% CI 0.593 to 0.926). None of the x-ray findings had a significant correlation to patient outcomes.

Conclusion There was no significant relationship between chest x-ray findings and outcomes in children with suspected VAP. **[Paediatr Indones. 2012;52:233-8]**.

Keywords: *chest x-ray, outcome, ventilator-associated pneumonia*

Ventilator-associated pneumonia (VAP) is the second most common nosocomial infection in PICU patients in the United States.[1,2] VAP is a nosocomial pneumonia in patients who have been mechanically ventilated for ≥48 hours, who develop signs of new lower respiratory tract infection. Despite advances in supportive care, antimicrobial therapies, and mechanical ventilation, VAP remains a major threat to ICU patients. In adults, the reported incidence of VAP ranges from 8% to 28% worldwide.[3,4] The incidence of VAP in pediatric patients varies from 5.1%-33.3%.[1,5,6] The National Nosocomial Infections Surveillance (NNIS) system of the Centers for Disease Control and Prevention (CDC) reported a mean VAP rate of 2.9 per 1000 ventilator days for participating PICUs in the United States.[7] The European Multicenter Study Group found the most common PICU nosocomial infection to be pneumonia, at 53% of all infections.[8] Adult patients who acquire VAP have worse outcomes and

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have longer ICU and hospital stays than children.[3] Of adult patients who require mechanical ventilation for ≥ 48 hours, 10 - 20% acquire VAP, with mortality rates of 15 to 50%.[8,9] Children with VAP have need for prolonged mechanical ventilation, longer ICU stays and higher mortality rates.[10,11]

The modified clinical pulmonary infection score (CPIS) is used to diagnose suspected VAP in children.[12] Definitive VAP may be diagnosed by bronchoscopic bronchoalveolar lavage (BAL) culture.[13] CPIS has a sensitivity of 80% and specificity of 80%.[12] Chest x-ray finding is one of the CPIS variables, defined as diffuse, localized or no infiltrates. Localized infiltrates score higher points than that of diffuse infiltrates.[14,15]

Chest x-ray findings as they relate to VAP outcomes are not as well documented in pediatric patients as they are in adults. VAP in adults has been associated with prolonged duration of mechanical ventilation, as well as increased length of ICU stay, hospital stay, hospital cost, and absolute mortality.[3] PICU patients not only encompass a wide range of ages different from adult ICU patients, but also differ in their developmental physiology, underlying disorders, and treatment needs. More pediatric VAP studies are needed to elucidate these factors.

We conducted a cross-sectional study in Dr. Kariadi Hospital to evaluate the relationship between chest x-ray findings and outcomes of children with suspected VAP.

Methods

This cross-sectional study was held at the Dr. Kariadi Hospital, University of Diponegoro, Semarang, Indonesia. This tertiary-care hospital receives referrals from the West Java region.

All pediatric and neonatal patients admitted to Dr. Kariadi Hospital from January to December 2010 were screened for study enrollment. We included patients who were mechanically ventilated for ≥ 48 hours and not diagnosed with pneumonia prior to PICU admission. Patients were excluded if their respiratory status was unstable (i.e., required fraction of inspired oxygen [FIO2] ≥ 80% or high frequency oscillatory ventilation), support was withdrawn or declaration of death was imminent. Unstable respiratory patients were eligible for enrollment if their clinical status improved. This study was approved by the institutional review board.

Data collected from medical records included demographic data (age at time of intubation, gender, and admission diagnosis), clinical signs (maximum temperature, presence of endotracheal secretions defined as non-purulent, purulent, or absent, FIO2 at time of the lowest PaO2), laboratory data (maximum white cell count, lowest PaO2 from arterial source), chest radiograph data (development of new infiltrates, diffuse infiltrates, localized infiltrates or no infiltrates) and culture data (results of endotracheal tube, blood, urine, and other tissue cultures). Data analysis included CPIS scores, chest radiograph data (diffuse, localized or no infiltrates), and patient outcomes defined as survived or died. Chest x-rays findings were determined as by the on-duty radiologist.

We used the modified CPIS score to diagnose suspected VAP, for which the sensitivity is 80% and specificity is 80%.[12] CPIS consists of 5 variables, one of which is radiologic findings as shown in **Table 1.**[13]

Chi-square was used to analyze the relationship between the chest x-ray findings, CPIS and outcomes. Logistic regression analysis was not used to assess a correlation between chest x-ray findings and outcomes since the Chi square analysis showed no significant correlation. Statistical analyses were performed with SPSS software version 17.0.

Results

Thirty-four patients met the inclusion criteria, but only 30 were enrolled, due to their FIO2 ≥ 80%. The outcomes of patients were survived (23 out of 30 children) and died (7/30). Subjects consisted of 14 males and 16 females. The mean age of the males was 46 (SD 42) months and of the females was 48 (SD 45) months.

We divided CPIS scores into 2 groups: those with scores of 6-7 (22 patients) for which the death rate was 2/22 and those with CPIS scores ≥ 8 (8 patients) for which the death rate was 5/8. We found significant relationships between CPIS and outcomes in the first group (OR= 0.06; P=0.007; 95% CI 0.008 to 0.461) and the second group (OR=16.67; P= 0.007; 95%

Table 1. The modified clinical pulmonary infection score[12]

CPIS parameters	0	1	2
Tracheal secretions	Rare	Abundant	abundant+purulent
Chest x-ray infiltrates	No infiltrates	Diffuse	Localized
Temperature	≧36.5 and ≦38.4	≧38.5. and ≦38.9	≧39 or ≦36
Leukocyte count, per mm^3	≧4,000 and ≦11,000	<4,000 or >11,000	<4,000 or >11,000+band forms ≧500
P_{AO2}/F_{IO2}, mmHg	>240 or ARDS		≦240 and no evidence of ARDS
Microbiology	Negative		Positive

Table 2. The relationship between CPIS and outcomes

CPIS score	Cases n	Survived n	Died n	OR	95% CI	P
6-7	22	20	2	0.06	0.008 to 0.461	0.007
≥ 8	8	3	5	16.67	2.167 to 128.17	0.007

Table 3. Pathogens cultured from endotracheal tubes

Pathogens	n
Acinetobacter baumanni	4
Enterobacter aerogenes	4
Pseudomonas aeruginosa	15
Staphylococcus aureus	2
Klebsiella pneumoniae	3
No pathogen growth	2

Table 4. The relationship between chest x-ray findings and outcomes

Chest x-ray	Case %	Survived %	Died %	OR	95% CI	P
Diffuse infiltrates	76.7	60	16.6	0.694	0.102 to 4.717	0.532
Localized infiltrates	13.3	6.7	6.7	4.200	0.470 to 37.499	0.225
No infiltrates	10	10	0	1.222	0.222 to 6.730	0.581

CI 2.167 to 128.17), as shown in **Table 2**.

One parameter of the CPIS score is microbiology, meaning pathogens found in endotracheal cultures. In our study, *Pseudomonas aeruginosa* was the most common isolated pathogenic microorganism, found in 15 endotracheal cultures. Other pathogens were *Acinetobacter baumanni* in 4 samples, *Enterobacter aerogenes* in 4 samples, *Staphylococcus aureus* in 2 samples and *Klebsiella pneumoniae* in 3 samples. No pathogens were found in 3 endotracheal cultures (**Table 3**).

The chest x-ray findings in our study of diffuse infiltrates (OR=0.694; P=0.532; 95% CI 0.102 to 4.717), localized infiltrates (OR=4.200; P= 0.225; 95% CI 0.470 to 37.49) and no infiltrates (OR=1.222; P= 0.436; 95% CI 0.593 to 0.926) had no significant relationships with patient outcomes as shown in **Table 4**.

Diffuse infiltrates was found in all region of the lung for most patients and this contributed one point of CPIS parameter (**Figure 1**). Most of them were survived.

Localized infiltrates was found in certain region of the lung and the most common location was in the right upper region of the lung (**Figure 2**). These chest x-ray findings were found in less number of patients than those with diffuse infiltrates, but contributed to more point of CPIS parameter. Localized infiltrate findings was significantly more common in patients with positive BAL (bronchoalveolar lavage) culture.

Discussion

VAP is pneumonia that develops after ≥48 hours of mechanical ventilation provided by way of an endotracheal tube or tracheostomy. VAP results from the invasion of the lower respiratory tract and lung parenchyma by microorganisms.[1,2,3] In our study, the death rate was 7 out of 30 patients (23.3%), within the mortality rate range from an adult study that reported the crude mortality rate for VAP to be 27-76%.[17]Outcomes of VAP have not been

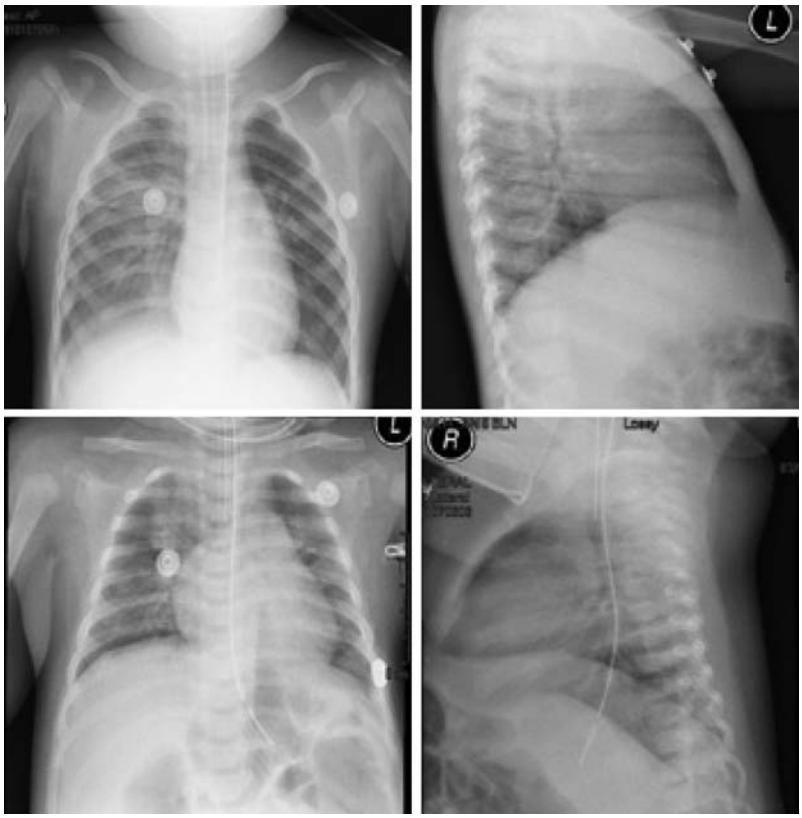

Figure 1. Chest x-ray findings of diffuse infiltrates

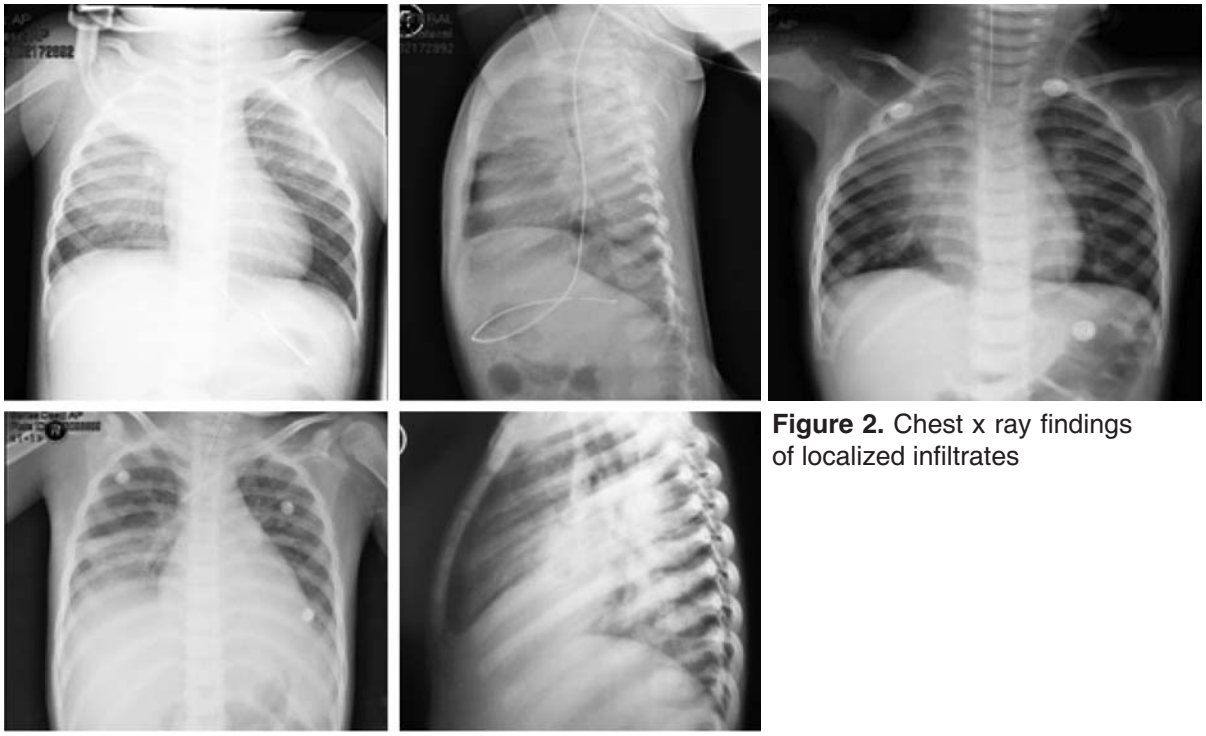

Figure 2. Chest x ray findings of localized infiltrates

documented as well in pediatric patients as in adults. Nevertheless, Srinivasan *et al*. found that children with VAP had increased absolute hospital mortality of 10.5%, compared to those without VAP.[10]

We used the modified CPIS score to diagnose suspected VAP, for which the sensitivity is 80% and specificity is 80%.[12] We found a significant relationship between CPIS and outcomes in the first group with scores of 6-7 (OR= 0.6; P=0.007; 95% CI 0.008 to 0.461) and in the second group with scores ≥ 8 (OR=16.67; P= 0.007; 95% CI 2.167 to 128.17).

We also found that the most common pathogen cultured was *Pseudomonas aeruginosa* (50%). Similarly, the NNIS in the United States and the European Multicenter Study Group found pneumonia in their pediatric populations to be most often associated with *Pseudomonas aeruginosa* (21.8%) and *S. aureus* (16.9%).[7,8] In contrast, Tripathi *et al*. reported that the most common bacteria isolated from endotracheal aspirates of VAP NICU patients was *Klebsiella spp* (32.8%).[18] This difference may be due to patients' encountering resistant *Enterobacter*, *Pseudomonas* and *Acinetobacter* species in late onset VAP (after 5 days of hospitalization), while the etiologic agent of bacterial community-acquired pneumonia differs by age which the most common bacterial cause of pneumonia among children between 3 weeks and older was *Streptococcus pneumonia*.[19]

Another parameter for CPIS is chest x-ray finding, defined as diffuse, localized or no infiltrates.[12] Localized infiltrates score higher points than diffuse infiltrates.[12] In our study, we did not find a significant relationship between chest x-ray findings and patient outcomes. Similarly, Sachdev *et al.* reported that of the five variables used for CPIS, only temperature and PaO_2/FiO_2 ratio were significant for assessing the presence of definite VAP.[12]

A limitation of our study was that we were unable to perform a Kappa test for the intraobserver agreement between radiologists, since this was a retrospective study. Also, our small sample size may have contributed to the lack of variable associations. A large, multicenter study should be done to better assess a relationship between chest x-ray findings and outcomes of children with suspected VAP. In conclusion, we found no significant relationship between chest x-ray findings and outcomes of children with suspected VAP.

References

1. Richards MJ, Edwards JR, Culver DH, Gaynes RP, National Nosocomial Infections Surveillance System. Nosocomial infections in pediatric intensive care units in the United States. Pediatrics. 1999;103:39.
2. Porzecanski I, Bowton DL. Diagnosis and treatment of ventilator-associated pneumonia. Chest 2006;130:597-604.
3. Chastre J, Fagon JY. Ventilator-associated pneumonia. Am J Respir Crit Care Med. 2002;165:867–903.
4. Rello J, Ollendorf DA, Oster G, Vera-Llonch M, Bellm L, Redman R, et al. Epidemiology and outcomes of ventilator-associated pneumonia in a large US database. Chest. 2002;122:2115-21.
5. Sharma H, Singh D, Pooni P, Mohan U. A study profile of ventilator-associated pneumonia in children in Punjab. J Trop Pediatr. 2009;55:393-5.
6. Asembergiene J, Gurkis V, Kevalas R, Valinteliene R. Nosocomial infection in pediatric intensive care units in Lithuania. Medicina (Kaunas). 2009;45:29-36.
7. National Nosocomial Infections Surveillance System. National Nosocomial Infections Surveillance System Report, data summary from January 1992 through June 2004, issued October 2004. Am J Infect Control. 2004;32:470–85.
8. Raymond J, Aujard Y. Nosocomial infections in pediatric patients: a European, multicenter prospective study. European Study Group. Infect Control Hosp Epidemiol. 2000;21:260–3.
9. Melsen WG, Rovers MM, Bonten MJ. Ventilator-associated pneumonia and mortality: a systematic review of observational studies. Crit Care Med. 2009;37:2709-18.
10. Srinivasan R, Asselin J, Gildengorin G, Wiener-Kronish J, Flori HR. A prospective study of ventilator-associated pneumonia in children. Pediatrics. 2009;123:1108-15.
11. Elward AM, Warren DK, Fraser VJ. Ventilator-associated pneumonia in pediatric intensive care unit patients: risk factors and outcomes. Pediatrics. 2002;109:758–764.
12. Sachdev A, Chuggh K, Sethi M, Gupta D, Wattal C, Menon G. Clinical pulmonary infection score to diagnose ventilator-associated pneumonia in children. Indian Pediatr. 2010;5:1-6.
13. Pugin J, Auckenthaler R, Mili N, Janssens JP, Lew PD, Suter PM. Diagnosis of ventilator-associated pneumonia by bacteriologic analysis of bronchoscopic and nonbronchoscopic "blind" bronchoalveolar lavage fluid. Am Respir Crit Med. 1991;143:1121-9.
14. Gauvin F, Dassa C, Chaibou M, Proulx F, Farrell CA, Lacroix J. Ventilator-associated pneumonia in intubated children:

comparison of different diagnostic methods. Pediatr Crit Care Med. 2003;4:437-43.
15. Fartkouth M, Maitre B, Honore S, Cerf C, Zahar JR, Brun-Buisson C. Diagnosing pneumonia during mechanical ventilation: the clinical pulmonary infection score revisited. Am J Respir Crit Care Med. 2003;168:173-9.
16. Evans HL. Chest x rays incongruous with lavage results in VAP. Internal Medicine News [serial on the Internet]. 2012 Apr 5 [cited 2012 June 5]. Available from: http://www.internalmedicinenews.com/index.php?id=514&tx_ttnews[tt_news]=133483&cHash=f85428468a296252210b76344b992ba8
17. Cook DJ, Walter SD, Cook RJ, Griffith LE, Guyatt GH, Leasa D, et al. Incidence of and risk factors for ventilator-associated pneumonia in critically ill patients. Ann Intern Med. 1998;129:433-40.
18. Tripathi S, Malik GK, Jain A, Kohli N. Study of ventilator-associated pneumonia in neonatal intensive care unit: characteristics, risk factors and outcome. Internet J Med Update. 2010;5:12-19.
19. Michelow IC, Olsen K, Lozano J, Rollin NK, Duffy LB, Ziegler T, Kauppila J, et al. Epidemiology and clinical characteristics of community-acquired pneumonia in hospitalized children. Pediatrics. 2004;113:701-7.