

Original Article

Correlation between chest x-ray findings and outcomes of patients with mechanical ventilation

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Abstract

Background Most infants and children admitted to the pediatric intensive care unit (PICU) have respiratory distress and pulmonary disease as underlying conditions. Mechanical ventilation may be used to limit morbidity and mortality in children with respiratory failure.

Objective To assess a correlation between chest x-ray findings and outcomes of patients with mechanical ventilation.

Methods This retrospective study was held in Dr. Kariadi Hospital, Semarang, Indonesia. Data was collected from the medical records of children admitted to the PICU from January to December 2010, who suffered from respiratory distress and used mechanical ventilation. We compared chest x-ray findings to the outcomes of patients. Radiological expertise was provided by radiologists on duty at the time. Chi-square and logistic regression tests were used for statistical analysis.

Results There were 63 subjects in our study, consisting of 28 males and 35 females. Patient outcomes were defined as survived or died, 43 subjects (68%) and 20 subjects (32%), respectively. Chest x-ray findings revealed the following conditions: bronchopneumonia 48% ($P=0.298$; 95%CI 0.22 to 1.88), pleural effusion 43% ($P=0.280$; 95%CI 0.539 to 4.837), pulmonary edema 6% ($P=0.622$; 95%CI 0.14 to 14.62) and atelectasis 3% ($P=0.538$; 95%CI 0.03 to 7.62). None of the chest x-ray findings significantly correlated to patient outcomes.

Conclusion Chest x-ray findings do not correlate to patient outcomes in pediatric subjects with mechanical ventilation in the PICU of Dr. Kariadi Hospital, Semarang, Indonesia. [Paediatr Indones. 2013;53:6-11.]

Keywords: Chest x-ray findings, PICU, mechanical ventilation

Most infants and children admitted to the PICU have respiratory distress and pulmonary disease as an underlying condition. Common respiratory diseases observed in these patients are pneumonia, bronchiolitis, lung hemorrhage, muscle diseases, and laryngotracheobronchiolitis. Respiratory diseases are the main cause of respiratory failure in children. Mechanical ventilation is used to limit morbidity and mortality in children with respiratory failure.^{1,2,3} Other conditions that may require mechanical ventilation are sepsis, septic shock, neuromuscular diseases, postoperative states, and cases of altered mental status with loss of consciousness, cardiovascular failure together with hypotension (heart failure, myocarditis, or cyanotic attack), and central nervous system (CNS) diseases (meningitis, encephalitis, coma, bleeding or tumor).^{3,4} In the average PICU, 30(range 20 – 64)% of patients are mechanically ventilated for a mean duration of 5–6 days.¹

This research was presented at the Asia Oceania Society for Pediatrics Radiology (AOSPR) Congress in Kuta, Bali in November 2011.

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Chest x-ray may be used to complement physical examinations.⁵ The chest x-ray is the most frequently requested form of radiographic imaging in the PICU, as it is performed routinely (on a daily basis and generally ordered without specific reason) or on demand (ordered due to clinical indication). Conditions requiring chest x-ray imaging are cardiopulmonary abnormalities, evaluation of an acute clinical deterioration and follow up as to the position of invasive life support devices, such as central venous catheters and endotracheal tubes.^{6,7} More than half of chest x-ray examinations in intensive care units are part of a daily-routine strategy, despite the doubtfulness of its value.⁸ The consensus opinion of the American College of Radiology (ACR) Expert Panel is that daily chest radiographs are indicated in patients with acute cardiopulmonary problems and those receiving mechanical ventilation.⁹

The objective of this study was to assess a correlation between chest x-ray findings and patient outcomes in pediatric subjects requiring mechanical ventilation in the PICU of Dr. Kariadi Hospital, Semarang, Indonesia.

Methods

This retrospective study was held in Dr. Kariadi Hospital, Semarang, Indonesia. Data was collected from medical records of children admitted to the PICU from January to December 2010. We included children aged 1 month or more, who used mechanical ventilation and were discharged before January 2011. We excluded post-surgical and trauma patients, as well as those with missing data in their medical records.

We obtained the following data from subjects' medical records: sex, age, date of admission and discharge, diagnosis and outcomes. Patients' ages were

recorded in months, then categorized as <1 year, 1 year to <5 years, and ≥5 years. Diagnoses were taken as the diagnosis on the date of admission to the PICU. Indication for PICU admission was cardiorespiratory problem with underlying diseases such as: heart failure, Dengue shock syndrome, diarrhea with severe dehydration, sepsis, CNS diseases, and lung diseases. Outcomes were defined as survived or died. Patients discharged at the request of their family due to their deteriorating condition were classified as died.

We compared chest x-ray findings to outcomes of patients. Radiological expertise was provided by the radiologist on duty at the time. Chi-square and logistic regression tests were used for statistical analysis. Demographic data were expressed as percentages (for sex, grouped age, chest x-ray findings, and outcomes) and mean (SD) for age in months. The primary hypothesis that chest x-ray findings were correlated to mortality outcomes of patients with mechanical ventilation was tested

Table 1. Subjects' characteristics

Characteristics	Total n=63	Outcomes	
		Survived n=43	Died n=20
Sex			
Males, n	28	19	9
Females, n	35	24	11
Age			
<1 year, n	24	15	9
1-<5 years, n	15	10	5
≥5 years, n	24	18	6
Mean age (SD), months	48.7 (46.0)		
Indication for mechanical ventilation			
Respiratory failure, n	7	4	3
Cardiovascular failure, n	33	26	7
CNS diseases, n	17	10	7
Sepsis, n	6	3	3

Table 2. Correlation between chest x-ray findings and outcomes

Chest x-ray findings	Total n=63	Outcomes		Odds ratio	95% CI	P value
		Survived n=43	Died n=20			
Bronchopneumonia, n (%)	30 (48)	19 (30)	11 (18)	0.648	0.22 to 1.88	0.298
Pleural effusion, n (%)	27 (43)	20 (32)	7 (11)	1.615	0.54 to 4.84	0.280
Pulmonary edema, n (%)	4 (6)	3 (4.8)	1 (1.6)	1.425	0.14 to 14.62	0.622
Atelectasis, n (%)	2 (3)	1 (1.6)	1 (1.6)	0.452	0.03 to 7.62	0.538



Figure 1. Bronchopneumonia

An eleven month old infant with status convulsivus and ventilator associated pneumonia. The antero-posterior chest x-ray shows infiltrates in superior right lobe and left paracardial.

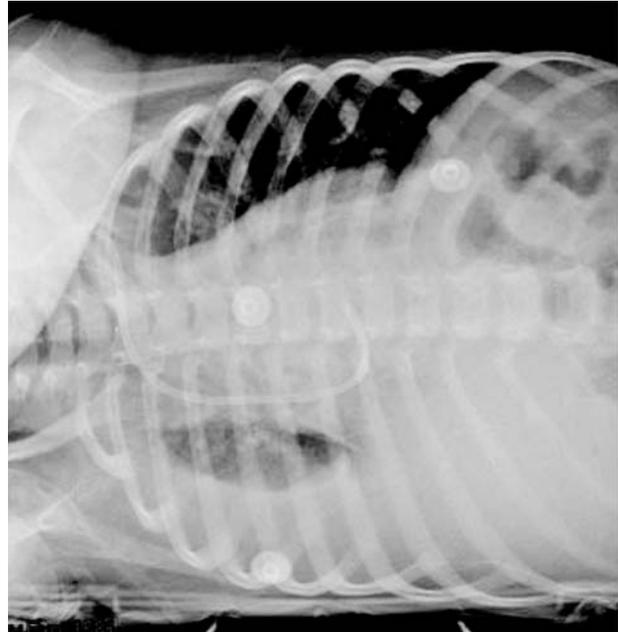


Figure 2. Pleural effusion

A six years old boy with Dengue shock syndrome. The right lateral decubitus chest x-ray shows pleural effusion with 34% pleural effusion index.



Figure 3. Pulmonary edema

A four year old girl with sepsis and leukemia. The antero-posterior chest x-ray shows pulmonary edema.



Figure 4. Atelectasis

A ten year old boy with Guillian Bare syndrome. The anteroposterior chest x-ray shows atelectasis of superior and inferior right lobes.

using chi-square test. All of the reported P values were two-tailed. P values and 95% CI were judged to indicate statistical significance.

Results

From January to December 2010, there were 116 medical patients admitted to the PICU at Dr. Kariadi Hospital, Semarang. From 116 patients, 63 patients met our inclusion criteria. Demographic and clinical characteristics of subjects are summarized in **Table 1**.

Subjects consisted of 28 males and 35 females. The number of patients aged < 1 year was equal to the number of patients aged 5 years or more. The mean age of subjects was 48.7 (SD 46.0) months. More than a half of our subjects needed mechanical ventilation because of cardiovascular failure, consisted of heart failure, Dengue shock syndrome, and diarrhea with severe dehydration. Other indication of ventilator usage were respiratory failure (pneumonia, severe asthma attack, and bronchiolitis), CNS diseases (encephalopathy, status convulsivus, Guillian Bare syndrome, and meningoencephalitis), and sepsis. Chest x-ray findings revealed the most frequently found condition was bronchopneumonia (48%), followed by pleural effusion (43%), pulmonary edema (6%) and atelectasis (3%), as summarized in **Table 2**. Furthermore, among patients who died, bronchopneumonia was the major chest x-ray finding (11/20).

Discussion

In our study, we found that distribution of male and female subjects was not markedly different (44% and 56%, respectively). Similarly, Srinivasan *et al*. found that PICU patients consisted of 57.6% males and 42.4% females.¹⁰ Also, Meaney *et al*. found no significant difference in the number of male and female patients admitted to the PICU ($P = 0.444$).¹¹ Similar results were reported by Kendirli *et al*. and Embu *et al*. with male to female ratios of 1.02:1 and 1.5:1, respectively.^{3,12}

The mean age of subjects in our study was 48.7 (SD 46.0) months with 62% of them under 5 years of age. Similarly, Kendirli *et al*. reported the mean age of their subjects to be 41.6 (SD 54.2) months with 75%

of all patients under 5 years of age.³ Furthermore, Edmunds *et al*. found that younger age and longer duration of mechanical ventilation were risk factors for mortality.¹³ Indications of ventilator usage in our study were cardiovascular failure (52.4%), CNS diseases (27%), respiratory failure (11.1%), and sepsis (9.5%). This result was different from study done by Kendirli *et al* and Payen *et al*. They reported that respiratory failure was the major indication for mechanical ventilation.^{3,14}

Chest x-ray findings revealed bronchopneumonia, pleural effusion, pulmonary edema and atelectasis in our subjects, with bronchopneumonia being the most common. This finding was similar to work by Chambliss *et al*.⁷ Chest radiographs are performed on PICU patients for many indications, although most are done routinely. Many studies have been undertaken to establish the efficacy of routine and non-routine chest radiographs.^{14,15,16} A meta-analysis by Oba *et al*., revealed that the elimination of daily routine chest radiography did not affect hospital or ICU mortalities.¹⁷ In a study to compare the diagnostic accuracy of auscultation, chest radiography and lung ultrasonography in acute respiratory distress syndrome, Lichtenstein *et al*. found that chest radiography had a diagnostic accuracy of 47% for pleural effusion, 75% for alveolar consolidation, and 72% for alveolar-interstitial syndrome.¹⁸

From the total of 63 patients in our study, 20 (32%) patients died. This result was similar to a study by Embu *et al*. who reported a mortality rate of PICU patients to be 36.1% in a retrospective study from January 1994 to December 2007.¹² However, Sands *et al*. reported a much lower PICU mortality rate, 5%, over a 10-year period (1997 - 2007).¹⁹ Yates K *et al*. reported a mortality rate of 14% during a 15 year study.²⁰ These results differ from our study because their subjects were patients with neuromuscular disease, followed for long periods of time, and some admitted to the PICU more than once.

The PICU mortality rate of 15% was found in a study to evaluate the use of PRISM scores.²¹ However, their patients were surgical and medical patients, and they excluded patients who died within the first eight hours after admission or who were discharged from the PICU within 24 hours of admission. In a six-month study in which all PICUs in the United Kingdom were enrolled, Brady *et al*. found that the mortality rate was

6.2%. The mortality rates for each PICU enrolled in that study ranged from 3.2% to 10.1%.²² Their results differ from our study because they enrolled all patients, both medical and surgical.

We found that there was no significant correlation between chest x-ray findings and mortality rates. There have been few studies assessing a correlation between chest x-ray finding and mortality rates, hence, we were unable to compare our results to that of other studies. Many risk factors may influence the mortality rate of PICU patients. Other studies have reported risk factors for increased PICU mortality to be invasive mechanical ventilation and prolonged duration of mechanical ventilation.²³ Blood glucose levels were also associated with morbidity (length of stay) and mortality among PICU patients as reported by Hirshberg *et al*.²⁴ and Kupper *et al*.²⁵ In a study using the pediatric logistic organ dysfunction (PELOD) score, Leclerc *et al*. reported that multiple organ dysfunction syndrome and a septic state influenced the mortality rate in critically ill children.²⁶ Since our work was a retrospective study, we were not able to gather complete historical data. Another limitation was that we could not do a Kappa test for interobserver agreement among radiologists for their x-ray assessments.

In conclusion, chest x-ray findings are not correlated to outcomes of PICU patients with mechanical ventilation. It is possible that the variety and severity of primary diseases, as well as complications during admission may have influenced the results.

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