

Blood Gas Analysis in Aspiration Pneumonia: Acute and Chronic Aspects

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ABSTRACT A retrospective cross-sectional study, was conducted between January 1st 1991 until December 31st 1996, to find out the acute and chronic aspects of changes of blood gases in aspiration pneumonia. A sample of all aspiration pneumonia patients hospitalized in Cipto Mangunkusumo Hospital, Jakarta, between January 1st, 1991 to December 31st, 1996 was selected (n=167). Data were obtained from the medical records. Only 65 patients were included in the study, from which 32 (49.2%) were males and 33 (50.8%) were females. Changes in blood gas analysis observed were decrease in PaO₂ (30.8%), normal PaCO₂ (30.8%) and decrease in PaCO₂ (60%) and abnormal oxygen saturation (80% in acute cases, and 11.1% in chronic cases). The prevalence of acute aspiration pneumonia was 30.8% and chronic aspiration pneumonia was 69.2%. Tachypnea, cyanosis, tachycardia and prolonged expiration were more prominent in the acute aspiration pneumonia as well as oxygen saturation which was more dominant parameter. We concluded that with blood gas analysis we would understand the natural course of the disease whether acute or chronic. [*Paediatr Indones* 1999; 39: 66-75]

Introduction

Aspiration pneumonia is defined as inhalation of liquid, solid mass or inhalant into the respiratory tract which on chest X-ray examination shows hyperinflation and segmental collapse of the lung.¹⁻⁴ It was first reported by Mendelson in 1946, in obstetric

patients who vomited during anesthesia, known as the Mendelson syndrome.^{1,2} In aspiration pneumonia, blood gas analysis plays an important role in the evaluation of the lung function as a respiratory organ.⁵⁻⁸ The clinical manifestations of aspiration pneumonia vary greatly, from mild to severe that may result in the death of the patient. To evaluate how long the process has been going on is not always easy regarding the patients condition and complication that results from aspiration pneumonia. Blood gas analysis is one of the important measures that further can be divided into acute and chronic cases.

Aspiration pneumonia results in decreasing pulmonary ventilation. It will further result in imbalance between ventilation and perfusion (decrease in V/Q ratio, mismatch ventilation) and the subsequent hypoxemia. This condition is known as acute condition, and it can be recognized by hyperventilation (increase in respiration rate). This effort will improve ventilation and the V/Q ratio becomes normal.¹⁰⁻¹² Another compensatory effort of the body is vasoconstriction of arterioles in the lung involved to decrease perfusion. In that instance V/Q ratio will reach normal value again. Other manifestation resulting from hypoxemia is tachycardia to increase stroke volume.¹⁰⁻¹² In the chronic aspiration pneumonia the compensatory effort has proceeded so that the mentioned clinical manifestation might diminish. This study aimed to determine features of blood gases in children with aspiration pneumonia

Methods

It was a retrospective study with cross-sectional design. The study population was all patients hospitalized at the Department of Child Health, Cipto Mangunkusumo Hospital for aspiration pneumonia from January 1, 1991 until December 31, 1996. All non-neonatal patients diagnosed as aspiration pneumonia from the chest X-ray were included.

Data was taken from medical records with the use special form and analyzed by Epi-info program version 6.04. The objectives of the study were; (1) to understand the demographic characteristics of aspiration pneumonia patients, (2) to evaluate blood gas analysis in aspiration pneumonia, (3) to classify aspiration pneumonia into acute and chronic cases based on the blood gas analysis in aspiration pneumonia.

Results

Patient characteristics

One hundred and sixty-seven patients of aspiration pneumonia were hospitalized in the Child Health Department of Cipto Mangunkusumo Hospital from January 1, 1991

to December 31, 1996, giving the average of 28 patients each year. The medical records were completed in 135. Only 65 cases had the diagnosis confirmed by chest X-ray film, from which 32 patients (49.2%) were boys and 33 (50.8%) were girls.

The youngest patient was 2 months old and the oldest was 6 years old (mean 10.4 months, mode 2.0 months). The age distribution is seen in Table 1, it shows that most patients (50 patients or 76.9%) of aspiration pneumonia occurred before 1 year of age, and the least affected was in the group of more than 5 years, i.e., only 1 patient. Aspiration pneumonia occurred equally in boys and girls. (Table 2)

Table 1. Patient characteristics

Patient characteristics	n	%
Total cases	65	(100)
▪ Male	32	(49.2)
▪ Female	33	(50.8)
Age group		
▪ < 1 year	50	(79.9)
▪ 1-5 year	14	(21.5)
▪ >5 year	1	(1.5)
Periode of onset before withdrawn blood gases		
▪ <24 hour	33	(50.8)
▪ 24-72 hour	25	(38.5)
▪ >72 hour	7	(10.7)
Final condition:		
▪ Recovered	41	(63.1)
▪ Death <24 hour	9	(13.9)
▪ Death >24 hour	14	(21.5)
▪ Other	1	(1.5)

Blood gas analysis changes

Data analyzed from blood gas analysis included PaO₂, PaCO₂ and oxygen saturation. The data were then classified into acute and chronic aspiration pneumonia and related to the clinical manifestations.

Table 3 shows the distribution of hypoxemia, which was classified as hypoxemic and non-hypoxemic group. Later the hypoxemic group became acute aspiration pneumonia and non-hypoxemic group became chronic aspiration pneumonia. Forty-five patients (69.2%) were defined as chronic and only 20 patients (30.8%) were defined as acute aspiration pneumonia.

Table 2. Sex and age distribution of patients

Sex	Age Group			Total	%
	<1 year n (%)	1-5 year n (%)	>5 year n (%)		
Male	24 (75.0)	7 (21.9)	1 (3.1)	32	(49.2)
Female	26 (78.8)	7 (21.2)	0 (0.0)	33	(50.8)
Total	50 (76.9)	14 (21.6)	1 (1.5)	65	(100.0)

Table 3. Distribution of hypoxemia in aspiration pneumonia

Hypoxemia	Total	%
Positive (PaO ₂ <80 mmHg)	20	30.8
Negative (PaO ₂ ≥80 mmHg)	45	69.2
Total	65	(100.0)

Table 4 shows the distribution of PaCO₂ in aspiration pneumonia. From 20 patients (30.8%) who had acute aspiration pneumonia, the distribution was almost similar (9 patients had normal PaCO₂, and 8 patients had PaCO₂ below normal). In the chronic aspiration pneumonia group, most had PaCO₂ below normal (31 patients, 60%).

Table 5 shows the distribution of oxygen saturation in aspiration pneumonia. In the acute group, most had the abnormal oxygen saturation (16 of 20 patients, 80%), and chronic group 40 of 45 patients (88.9%) had normal oxygen saturation. The difference is statistically significant ($p = 0.000$).

Table 4. Distribution of PaCO₂ in aspiration pneumonia

Aspiration pneumonia	PaCO ₂ (mmHg)			Total	%
	<35	35-45	>45		
	n (%)	n (%)	n (%)		
Acute	8 (40.0)	9 (45.0)	3 (15.0)	20	(30.8)
Chronic	32 (68.9)	11 (24.0)	3 (6.7)	45	(69.2)
Total	39 (60.0)	20 (30.8)	6 (9.2)	65	(100)

Table 5. Distribution of oxygen saturation

Aspiration pneumonia	SATURATION		Total	%
	Abnormal (<90%)	Normal (>90%)		
	n(%)	n(%)		
Acute	16 (80.0)	4 (20.0)	20	(30.8)
Chronic	5 (11.1)	40 (88.9)	45	(69.2)
Total	21 (32.3)	44 (67.7)	65	(100.0)

$$\chi^2=29.58; p=0.000$$

Clinical manifestations

Table 6 shows the distribution of patients who had tachycardia, tachypnea, cyanosis and prolonged expiration between acute and chronic aspiration pneumonia group. In the acute group, the more frequent clinical manifestations were tachypnea (55%) and prolonged expiration (85%). Tachycardia and cyanosis were only found in 5 patients (25%) and 9 (55%) respectively. Mean while in the chronic group, 60% still had tachypnea and 86.7% had prolonged expiration.

Relationship between clinical manifestation and blood gas analysis in aspiration pneumonia

Table 7 shows the relationship between some clinical manifestations found in the patient and the oxygen saturation in each group. In the acute aspiration pneumonia group, in all clinical manifestations (tachycardia, cyanosis, tachypnea and prolonged

expiration) the proportion of patients who had abnormal oxygen saturation was greater than in patients who had normal oxygen saturation. It is obvious that more than 80% had abnormal oxygen saturation. On the contrary, in the chronic aspiration pneumonia group, the proportion of patients who had normal oxygen saturation was greater than those who had abnormal oxygen saturation in all clinical manifestations except tachycardia.

Table 6. Distribution of clinical manifestation in aspiration pneumonia acute and chronic

Aspiration pneumonia	Tachycardia	Tachypnea	Cyanosis	Prolonged expiration
	n (%)	n (%)	n (%)	
Acute	5 (25.0)	11 (55.0)	9 (45.0)	17 (85.0)
Chronic	8 (17.8)	27 (60.0)	13 (28.9)	39 (86.7)

Table 7. Distribution of clinical manifestations and oxygen saturation in aspiration pneumonia

Clinical manifestations	Acute		Chronic	
	Abnormal saturation	Normal saturation	Abnormal saturation	Normal saturation
	n (%)	n (%)	n (%)	n (%)
Tachycardia	5 (100)	0 (0.0)	4 (50.0)	4 (50.0)
Cyanosis	8 (88.9)	1 (11.1)	4 (30.8)	9 (69.2)
Tachypnea	15 (88.2)	2 (11.8)	2 (18.2)	22 (81.5)
Prolonged expiration	9 (81.9)	2 (18.2)	5 (12.8)	34 (87.2)

Discussion

Study limitations

The number of subjects was not sufficient because many clinical and radiological data could not be found. The retrospective nature of the study implied that the patients was

not managed uniformly. Furthermore, no information on oxygen therapy that could influence the gas analysis results was provided. Due to the cross sectional study design, no cause-effect relationship could be concluded.

General description

During the study period, 167 hospitalized patients were diagnosed as suffering from aspiration pneumonia. They constituted 1.22% of all children admitted to the Children Ward of RSCM during the same period. The fact showed that aspiration pneumonia incidence was quite rare. Of 65 patients included in this study, the number of male was similar to that of female, i.e., is 32 males and 33 females. This was different from previous studies that showed higher incidence in male with uncertain cause.^{5,8}

Pneumonia aspiration in children is often caused by insufficient gastroesophageal sphincter that facilitate regurgitation and then aspiration. The highest incidence was found in the age group of less than 1 year (50 patients or 76.9%). It seems that aspiration was the result of carelessness when giving milk among hospitalized patients with various diseases, cause the symptoms often occurred after the patient drinks, vomits and then chokes on the milk.

Clinical signs

Amongst clinical signs observed were the signs of tachypnea, cyanosis, tachycardia and prolonged expiration. Other manifestations such as hypotension, stridor, and shock^{2,4,5} could not be included in the study because of lack of data.

Tachypnea and cyanosis usually are the initial symptoms most easily observed by the parents. Both symptoms are the result of hypoxemia caused by disorder of the lung ventilation function. Symptoms usually appear within 24 hours after aspiration. If the accident occurs outside the hospital, the sign of cyanosis usually diminished on arrival but tachypnea still persists. The compensatory mechanism of the body toward hypoxemia is the explanation.^{2,5}

Tachycardia is also related to the tachypnea and cyanosis, both stand as cardiovascular compensation of hypoxemic condition. In this study we only found 13 patients (20%) with tachycardia, which could be resulted from mistake in pulse rate counting that was not counted in one full minute time.

Blood Gas Analysis

Blood gas analysis data studied included PaO₂, PaCO₂ and oxygen saturation. Blood samples were being handled differently between those with or without oxygen. Table 3 shows that most of the samples, i.e. 45 (69.2%) patients had normal PaO₂. The result was different from other studies that showed hypoxemia being an initial sign of

decrease lung function from uneven ventilation.^{3,13,14} This condition might be encountered because before the blood sample was taken, the patient usually had received an emergency care such as clearing the respiratory tract and oxygen administration.

Determining the pneumonia as acute or chronic was not easy. The blood gas analysis only shows that it might have been an acute condition if the sign of hypoxemia was counted, but it might have been reversed condition without sign of hypoxemia.¹⁵⁻¹⁷

Our study revealed that 20 (30.8%) patients had acute aspiration and 45 (69.2%) patients had chronic condition. This is in accordance with the literature that stated that chronic aspiration incidence is much higher than the acute ones. Chronic aspiration pneumonia could be missed although radiological examination already shows the defect.¹⁸⁻²⁰

Changes in blood gas analysis profile have many variations due to its process in developing an adequate compensation mechanism of the body. If the target was not reached the patient would suffer from respiratory failure and die, but if the mechanism could overcome the condition then the patient would recover.

Besides the changes in PaO₂ concentration, oxygen saturation was also changed. This condition showed by abnormal oxygen saturation in 80% patients, whereas 88.9% of chronic pneumonia aspiration had normal oxygen saturation. This is in accordance with the literature that stated the change in oxygen saturation in acute aspiration pneumonia was caused by compensation mechanism as the results of uneven ventilation. It seemed that oxygen saturation changes were the important parameter in this study.

Relationship between symptoms and oxygen saturation value

This study tried to find correlation between symptoms of acute and chronic aspiration pneumonia. Oxygen saturation was one of the observed parameters to determine the presence of uneven ventilation. As been mentioned before, abnormal saturation value was often found in acute condition. Statistics test done to certain conditions such as tachycardia, cyanosis, and prolonged expiration came up with significant results for the cyanosis and prolonged expiration but not to the tachycardia. All acute aspiration pneumonia patients had abnormal oxygen saturation. The same things happened to the cyanosis and prolonged expiration groups.

The influence of the clinical symptoms of the aspiration pneumonia to the oxygen saturation was enormous. Chronic aspiration showed normal oxygen saturation due to the compensation mechanism of the body. This also in accordance with previous studies results that stated that the clinical signs improved with the disappearance of the uneven ventilation.

In summary, we have found that the prevalence of aspiration pneumonia in Child Health Department of our hospital was 1.22% of all admitted patients with equal male

to male prevalence. Among those, age group of less than 1 year was the most prevalent and tended to decrease as the age increase. Aspiration pneumonia can be divided into acute and chronic based on the existence of uneven ventilation. Acute aspiration pneumonia was 30.8% and chronic aspiration pneumonia was 69.2%. Changes in blood gas analysis profile were decreased PaO₂ (30.8%), decrease PaCO₂ (60%). Oxygen saturation was decreased in 80% acute condition and 11.1% chronic condition. Oxygen saturation value has correlation with clinical manifestations of aspiration pneumonia. The clinical manifestation was more prominent in acute than in chronic aspiration pneumonia. The prospective study should be conducted to find out the real incidence and clinical manifestation of aspiration pneumonia.

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