

Original Article

PROFILE OF PATIENTS WITH RESPIRATORY FAILURE AT PEDIATRIC INTENSIVE CARE UNIT (PICU) DR. SOETOMO GENERAL HOSPITAL

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ABSTRACT

Introduction: Respiratory failure is the *respiratory system's inability* to maintain its gas exchange functions, oxygenation and carbon dioxide elimination. Infant and children are more susceptible to develop respiratory failure. Respiratory failure can also be caused by several diseases/conditions, which is a common reason for pediatrics to be admitted to the intensive care unit. **Objective:** This study aims to describe *patients'* demographic and clinical profile with respiratory failure at the PICU of Dr. Soetomo General Hospital, Surabaya. **Materials and Methods:** This is a prospective study with the descriptive method using the medical records of patients with respiratory failure who were admitted to the PICU from September 2019 to February 2020 and had arterial BGA data (PaCO₂, PaO₂), which were examined in the PICU or resuscitation room before the patients were admitted to the PICU. **Results:** This study showed that out of 35 patients, 24 (68.6%) were female, 19 (54.3%) were <1 year old, and 20 (57.1%) had normal nutritional status. Type I (hypoxemic) and type II (hypercapnic) respiratory failures were found in 13 patients (37.1%), respectively. The most common clinical signs were fever in 26 patients (74.3%), shortness of breath in 24 patients (68.6%), and chest retraction in 24 patients (68.6%). The primary diagnosis that commonly occurred was respiratory system disorders in 15 patients (42.9%). The *other* diagnosis that *mainly* occurred was nutrition and metabolic disorders of 19 patients (54.3%). The *patients' outcome* was that 24 patients were survived (68.6%), and *ten* patients died (28.6%). **Conclusions:** Various clinical signs and diagnoses can be found in patients with respiratory failure at PICU. The most common *respiratory failure types* are type I (hypoxemic) and type II (hypercapnic) respiratory failure.

Keywords: Chronic Respiratory Disease; Hypoxemia; Hypercapnic; PICU; Profile; Respiratory Failure

ABSTRAK

Pendahuluan: Gagal napas merupakan kondisi kegagalan sistem pernapasan dalam melakukan fungsi pertukaran gas yaitu oksigenasi dan eliminasi karbondioksida. Gagal napas lebih rentan terjadi pada bayi dan anak, dan dapat disebabkan oleh beberapa penyakit/kondisi yang mendasari, sehingga gagal napas menjadi alasan umum pasien pediatri dirawat di unit perawatan intensif. **Tujuan:** Penelitian ini bertujuan untuk menggambarkan profil demografi dan klinis pasien dengan gagal napas di PICU RSUD Dr. Soetomo. **Metode dan Bahan:** Penelitian ini merupakan studi prospektif dengan metode deskriptif menggunakan rekam medis pasien dengan gagal napas yang masuk PICU pada September 2019 hingga Februari 2020 dan memiliki data BGA arteri (PaCO₂, PaO₂) yang diperiksa di PICU atau ruang resusitasi sebelum pasien masuk PICU. **Hasil:** Penelitian ini menunjukkan bahwa dari 35 pasien, 24 pasien (68,6%) berjenis kelamin perempuan, 19 pasien (54,3%) berusia <1 tahun, dan 20 pasien (57,1%) memiliki status gizi normal. Gagal napas tipe I (hipoksemia) dan gagal napas tipe II (hiperkapnia) ditemukan pada masing-masing 13 pasien (37,1%). Tanda klinis yang paling sering ditemukan adalah demam pada 26 pasien (74,3%), sesak napas pada 24 pasien (68,6%), dan retraksi dada pada 24 pasien (68,6%). Diagnosis utama terbanyak adalah gangguan sistem respirasi yaitu pada 15 (42,9%) pasien, dan diagnosis tambahan terbanyak adalah gangguan nutrisi dan metabolik yaitu pada 19 (54,3%) pasien. Hasil luaran pasien yaitu hidup sebanyak 24 pasien (68,6%), dan meninggal sebanyak 10 pasien (28,6%). **Kesimpulan:** Pada pasien dengan gagal napas di PICU, ditemukan tanda klinis dan diagnosis yang bervariasi. Tipe gagal napas yang paling banyak ditemukan yaitu gagal napas tipe I (hipoksemia) dan tipe II (hiperkapnia).

Kata kunci: Penyakit Pernapasan Kronis; Hipoksemia; Hipercapnia; PICU; Profil; Gagal napas

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INTRODUCTION

The respiratory system's primary function is to carry out the gas exchange that helps maintain cellular homeostasis (1). Respiratory failure is when the respiratory system fails to maintain gas exchange functions, namely oxygenation and/or carbon dioxide elimination, to meet the body's metabolic needs. Respiratory failure based on blood gas abnormalities is classified into hypoxemic ($\text{PaO}_2 < 60$ mmHg), hypercapnic ($\text{PaCO}_2 > 50$ mmHg), and mixed (2,3).

Respiratory failure can be caused by various conditions, namely lung disease, airway disorders, respiratory pump problems, central nervous system disorders, and inability to meet increased metabolic demands, such as hypovolemia, septic shock, cardiac insufficiency, metabolic disease, or intoxication (4). In pediatric patients, respiratory failure is often initiated by acute respiratory distress syndrome (ARDS), with the incidence of ARDS in the population of 3.5 cases per 100,000 people in one year, while in the Pediatric Intensive Care Unit (PICU), it was 2.3% (5).

Acute respiratory failure is a medical emergency that is more susceptible to occur in infants and children. High susceptibility and clinical manifestations that develop more severely and rapidly in pediatrics cause acute respiratory failure to be a common reason for pediatric patients to be admitted to the PICU (4). Respiratory failure can be the cause of high morbidity and mortality rates in intensive care units (6). The mortality rate for pediatric due to ARDS in the previous study was approximately 24-34% (5,7).

Currently, there has not been much research on the profile of pediatric patients with

respiratory failure in the intensive care unit, especially Dr. Soetomo General Hospital, Surabaya. This study is expected to provide information regarding pediatric patients' demographic and clinical profile with respiratory failure admitted to the PICU at Dr. Soetomo General Hospital, Surabaya.

MATERIALS AND METHODS

This study used the descriptive method prospectively conducted at the Pediatric Intensive Care Unit (PICU) Dr. Soetomo General Hospital Surabaya. This study period was September 2019 to July 2020. Thirty-five patients met the inclusion criteria, namely patients aged >28 days to 18 years old with respiratory failure admitted to the PICU from September 2019 to February 2020. They had arterial BGA data (PaCO_2 , PaO_2) examined in the PICU or resuscitation room before the patient was admitted to the PICU.

Data were collected from the patient's medical record, including gender, age, nutritional status based on body weight and length/height, type of respiratory failure based on the data of arterial BGA (PaCO_2 , PaO_2), clinical signs, primary diagnosis, additional diagnosis, and patient outcomes. Assessment of children's nutritional status based on body weight according to length/height refers to WHO 2006 chart for children <5 years and the CDC 2000 chart for children >5 years. Furthermore, children <5 years can use the weight index according to age refers to WHO 2006 chart to assess children with underweight and severely underweight (8,9). Types of respiratory failure in patients were classified based on arterial BGA data, namely type I or hypoxemic respiratory failure ($\text{PaO}_2 < 60$ mmHg), type II or hypercapnic respiratory

failure ($\text{PaCO}_2 > 50$ mmHg), and type III respiratory failure (a combination of hypoxemic and hypercapnic)(3). The data were analyzed using Statistical Program for Social Sciences (SPSS) v26.0 software to show the frequency, percentage, and data distribution. The Ethics Committee of Dr. Soetomo General Hospital, Surabaya, has approved this research (1335/KEPK/VII/2019).

RESULTS AND DISCUSSION

The total number of patients with respiratory failure who met the inclusion criteria was 35 patients. Females dominated the patient's characteristics based on gender as many as 24 patients (68.6%). The ratio between males and females was 1:2.18. The characteristics of the patient based on age group were dominated by the infant age group (<1 year) of 19 patients (54.3%). The patient had a median age of 9 months, with the youngest being one month and the oldest being 17 years.

Table 1. Demographic Characteristics of Patients

Characteristics	N (%)
Gender	
Male	11 (31.4)
Female	24 (68.6)
Age group	
Infants (<1 year)	19 (54.3)
Children (1-10 years)	10 (28.6)
Adolescents (11-18 years)	6 (17.1)
Nutritional status	
Obese	3 (8.6)
Overweight	1 (2.9)
Normal	20 (57.1)
Wasted	5 (14.3)
Severely wasted	4 (11.4)
Severely underweight	2 (5.7)

The number of research samples that had complete data in the form of body weight and body length/height were 33 patients from a total of 35 patients, and thereby the nutritional status assessment of 33 patients was conducted based on Ikatan Dokter Anak Indonesia recommendations, namely using the

weight index according to length/height(8). While two patients aged <5 years only had data in the form of body weight using the weight index according to age. The results showed that most patients who had a normal nutritional status were 20 patients (57.1%). The demographic profiles of the patients are shown in Table 1.

Type I (hypoxemic) respiratory failure and type II (hypercapnic) respiratory failure of 13 patients (37.1%), respectively, dominated the types of respiratory failure in patients. The distribution of the types of respiratory failure in the research subjects is shown in Table 2.

Table 2. Type of Respiratory Failure

Type	N (%)
Type I (hypoxemia)	13 (37.1)
Type II (hypercapnic)	13 (37.1)
Type III (mixed)	9 (25.7)

Clinical signs and symptoms primarily found in patients with respiratory failure were fever in 26 patients (74.3%). Moreover, the most frequent signs of respiratory distress were shortness of breath and chest retraction in 24 patients (68.6%), respectively. The distribution of clinical signs found in research subjects is shown in Table 3.

Table 3. Clinical Signs of Patients

Clinical Sign*	N (%)
Fever	26 (74.3)
Cough	14 (40)
Shortness of breath	24 (68.6)
Chest retraction	24 (68.6)
Wheezing	11 (31.4)
Pale	20 (57.1)
Cyanosis	4 (11.4)

*each patient could experience more than one clinical signs

The primary diagnosis primarily found in patients with respiratory failure was respiratory system disorders in 15 patients (42.9%), followed by central nervous system disorders in 7 patients (20%). Patients with respiratory failure in the PICU also experience conditions or problems other than the primary

diagnosis. The other diagnoses mostly occurred to the research subjects were nutrition and metabolic disorders of 19 patients (54.3%). The distribution of the primary and additional diagnoses among the research subjects is shown in Table 4.

Table 4. The Primary and Additional Diagnosis of Patients

Diagnosis	N (%)
Primary diagnosis	
Respiratory system	15 (42.9)
Central nerve system	7 (20)
Gastrointestinal system	4 (11.4)
Renal system	4 (11.4)
Cardiovascular system	2 (5.7)
Hematologic system	2 (5.7)
Nutrition and metabolic	1 (2.9)
Additional diagnosis*	
Nutrition and metabolic	19 (54.3)
Cardiovascular system	15 (42.9)
Respiratory system	14 (40)
Renal system	12 (34.3)
Sepsis	11 (31.4)
Gastrointestinal system	7 (20)
Hematologic system	7 (20)
Central nerve system	5 (14.3)

* each patient could have more than one additional diagnosis

The patient's outcome is the condition of the patient with respiratory failure in the PICU. This study found that 24 patients (68.6%) were survived, 10 patients (28.6%) died in the PICU, and 1 patient (2.9%) was still undergoing treatment in the PICU at the end of this study. The patient outcomes are shown in Table 5.

Table 5. The Outcome of Patients in PICU

Outcome	N (%)
Survived	24 (68.6)
Died	10 (28.6)
Others	1 (2.9)

This study found that the characteristics of patients with respiratory failure in the Pediatric Intensive Care Unit Dr. Soetomo General Hospital were dominated by the female of 68.6% compared to the male of 31.4%. This is different from previous studies

in Indian general hospitals: Lokmanya Tilak Municipal Medical College and Dayanand Medical College, where most pediatric patients with respiratory failure were male (10,11). This difference may be caused by a more extended study time and several other rooms as the research location.

The characteristics of patients with respiratory failure based on age were dominated by the infant age group (<1 year), with a percentage of 54.3%. The infant age group is more susceptible to develop respiratory failure because physiologically, there are several deficiencies, such as the smaller diameter of the infant respiratory tract so that resistance to airflow increases rapidly when there is secretion, edema, or bronchoconstriction, immaturity of the chest wall and diaphragm, a more horizontal orientation of the ribs and diaphragm, more oxygen consumption than adults in normal circumstances, and immaturity of respiratory control centers (1,12). Other studies at Lokmanya Tilak Municipal Medical College and Dayanand Medical College General Hospital showed the same results that the majority of pediatric patients with respiratory failure were in the 1 month to 1 year age group (10,11).

Furthermore, the characteristics of patients with respiratory failure based on nutritional status were dominated by the normal nutritional status of 57.1%, followed by wasted of 14.3%, and severely wasted by 11.4%. In pediatric patients ventilated in the PICU, nutritional status was significantly associated with clinical outcomes. Assessment of nutritional status is conducted on patients who are treated at the PICU so that patients who are malnourished are considered in the optimal nutrition strategy aimed at preventing further nutritional deterioration (13).

The types of respiratory failure in patients were categorized based on arterial BGA data

(PaCO₂, PaO₂). The majority of patients in the PICU who developed type I (hypoxemic) respiratory failure and type II (hypercapnic) respiratory failure were 13 patients (37.1%), respectively, followed by type III (mixed) respiratory failure as many as 25.7%. Another study at Lokmanya Tilak Municipal Medical College general hospital revealed that respiratory failure in pediatric patients was dominated by type I and type III (38%, respectively) (10). While research conducted at the Dayanand Medical College General Hospital reported that hypoxemic respiratory failure (type I) was the most common type in pediatric patients (74.78%) (11).

The clinical signs and symptoms of respiratory failure are often not specific to a particular respiratory disease, but it depends on the underlying disease and the hypoxemic and hypercapnic levels (4,14). This study showed that the clinical sign that most commonly found in patients with respiratory failure in PICU was fever, with a percentage of 74.3%. These results are consistent with the Dayanand Medical College General Hospital research, which states that fever was found in many pediatric patients with respiratory failure of 68.7% (11). Fever often occurs in patients during their treatment at the PICU and is found in more than 40% of critically ill children at the PICU (15). Moreover, the most common signs of respiratory distress found were shortness of breath and chest retraction of 68.6%, respectively. Changes in breathing depth and pattern and chest retraction can be seen in pediatric patients with respiratory failure as a sign of increased work of breathing (4)(10). Other clinical signs found in patients with respiratory failure in the PICU were cough by 40%, wheezing by 31.4%, pale by 57.1%, and cyanosis by 11.4%.

The primary diagnosis in pediatric patients with respiratory failure may vary. The research results found that the most common

primary diagnosis in patients with respiratory failure at the PICU Dr. Soetomo Surabaya General Hospital is a respiratory system disorder (42.9%), followed by a central nervous system disorder (20%). These results are consistent with other studies at Lokmanya Tilak Municipal Medical College and Dayanand Medical College general hospitals, which reported that the majority of underlying diseases in pediatric patients with respiratory failure were respiratory system disorders, followed by nervous system disorders (10,11).

Also, patients with respiratory failure at the PICU of Dr. Soetomo Surabaya General Hospital are experiencing conditions or problems but the primary diagnosis. The additional diagnosis primarily found in the research subjects was nutrition and metabolic disorder (54.3%). The nutrition and metabolic disorders found in the patients were malnutrition, acid-base balance disorders, electrolyte disturbances, and hypoalbuminemia. Disturbances of acid-base and electrolyte balance are often found in critically ill children. It may occur due to underlying pathophysiologies, such as kidney failure, respiratory failure, and shock. This disorder can be severe and is often associated with poor outcomes (16). Hypoalbuminemia is also a condition that is not uncommon in critically ill children. In the adult patient literature, hypoalbuminemia is a marker of disease severity, also associated with prolonged mechanical ventilation and length of stay in intensive care unit (17).

This study found that most patients with respiratory failure who were being discharged from the PICU were alive as many as 68.6%, while the death outcome was 28.6%, and patients who were still undergoing treatment at the end of the study period was 2.9%. The relation between the outcome of patients and respiratory failure types found that the highest patient mortality rate was in patients with type

III (mixed) respiratory failure by 33.3%, followed by type I (hypoxemic) respiratory failure by 30.8%, and type II (hypercapnic) respiratory failure by 25%.

CONCLUSION

Patients with respiratory failure in PICU were dominated by female, infant age group (<1 year), and normal nutritional status. Patients with respiratory failure may experience clinical signs and may have a variety of diagnoses. The types of respiratory failure mostly found were type I (hypoxemic) respiratory failure and type II (hypercapnic) respiratory failure.

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