CHARACTERISTIC OF MECHANICALLY VENTILATED CHILDREN IN PEDIATRIC INTENSIVE CARE UNIT (PICU)

Aisya Azzahra Sudarmanto[1*], Neurinda Permata Kusumastuti[2], Arie Utariani[3]
Fakultas Kedokteran Universitas Airlangga Surabaya[1], Departemen Anak RSUD Dr. Soetomo Surabaya[2], Departemen Anestesiologi dan Reanimasi RSUD Dr. Soetomo Surabaya[3]
**Corresponding Author :* neurindapermata@yahoo.com

ABSTRAK

Ventilator Mekanik (VM) merupakan alat bantu kehidupan yang dapat membantu pasien untuk bernapas dengan menjaga oksigen yang adekuat dan ventilasi yang cukup sampai dengan penyakit yang mendasari terselesaikan. Oleh karena itu, data tentang admisi dan perawatan anak-anak pengguna Ventilator Mekanik dengan penyakit kritis di Ruang Perawatan Intensif Anak (PICU) terutama di negara berkembang sangat penting. Namun, informasi dan data mengenai admisi dan penggunaan VM di Ruang Perawatan Intensif Anak susah untuk dicari dan ditemukan. Hal ini menyebabkan kesulitan untuk meningkatkan pelayan perawatan dan hasil akhir luaran pasien. Penelitian ini bertujuan untuk mengetahui karakteristik admisi dan perawatan pasien anak dengan penggunaan VM di Ruang Perawatan Intensif Anak di RSUD Dr. Soetomo Surabaya, sehingga diharapkan hasil dari penelitian dapat digunakan untuk meningkatkan pelayanan perawatan pasien anak di Ruang Perawatan Intensif Anak di Seluruh Indonesia khususnya di Surabaya. Penelitian ini menggunakan metode penelitian deskriptif retrospektif. Dari pengumpulan data, ditemukan sebanyak 111 pasien memenuhi kriteria inklusi. Mayoritas pasien yang dirawat di Ruang Perawatan Intensif Anak adalah pasien bayi sebanyak 55 pasien (49.55%), dengan pasien laki-laki sebanyak 64 pasien (57.66%) dan dengan status nutrisi kurang sebanyak 35 pasien (53.84%). Mayoritas pasien dirawat di Ruang Perawatan Intensif Anak karena masalah sistem pernapasan sebanyak 46 pasien (41.44%).

Kata kunci : anak-anak, penyakit kritis, PICU, ventilator mekanik

ABSTRACT

Mechanical Ventilator (MV) is a life support machine that aids patients to breathe by maintaining adequate oxygenation and ventilation processes until the underlying disease is resolved. Because of that, the data about admission and treatment of critically ill children using Mechanical Ventilator (MV) in Pediatric Intensive Care Unit (PICU) in developing countries is very crucial. Yet the information and data regarding the usage of MV in PICU are very hard to find, causing it difficult to improve the outcome and provision of aid for the patient. This study aims to obtain data about characteristic of admission and care of critically children using mechanical ventilator in PICU at RSUD Dr. Soetomo Surabaya. The writers hoped that this research can be used to improve patient care services in PICU throughout Indonesia, especially in Surabaya. This study was conducted using a retrospective descriptive method. From the data that has been obtained, it is found that a total of 111 patients met the inclusion criteria. It is also found that most of the patients treated at PICU are male numbering 64 patients (57.66%) with majority of the patients are infants numbering 55 patients (49.55%) with wasted nutritional status numbering 35 patients (53.84%). The majority of the patients were admitted to PICU because of respiratory problems numbering 46 patients (41.44%).

Keywords *: PICU, mechanical ventilator, critically ill, children*

INTRODUCTION

Mechanical Ventilator (MV) is a life support machine that aids patients to breathe by applying a positive pressure breath and related to the compliance and resistance of the airway system (Hickey & Giwa, 2023). Through another study conducted in Surabaya, Indonesia, it stated that while using MV, the overall respiratory system improves by maintaining adequate oxygenation and ventilation processes until the underlying pathological process of the disease

is resolved (Aina et al., 2020). However, not all patients admitted to Pediatric Intensive Care Unit (PICU) has a high tendency of using MV. If the patient increasing respiratory rate, asynchronous respiratory pattern, changing in level of consciousness, frequent oxygen desaturation in high oxygen level, hypercapnia, respiratory acidosis, and circulatory problem such as hypotension and atrial dysrhythmias the patient needs to use MV immediately (Popat & Jones, 2012). From the research that held in Cortland, New York, USA, the result stated that respiratory failure (pneumonia, bronchiolitis, lung hemorrhage, muscle disease, and laryngotrach eobronchiolitis), cardiovascular failure together with hypotension (myocarditis, heart failure, spell attack), central nervous system disease (meningitis, encephalitis, bleeding, coma, and tumor), septic shock, and safety airway, especially critical situation like sepsis are the indications of MV in PICU (Kendirli et al., 2006).

Regarding the utilization of MV, a study conducted at PICU of RSUD Dr. Wahidin Sudirohusodo Makassar, Indonesia, stated that among 53 patients on PICU 23 of them (43.4%) were using MV (Danisa Hasmuddin et al., 2022). Meanwhile, RSUP H. Adam Malik, Indonesia, found out that 206 patients were admitted to PICU and ventilated. From 206 patients, postoperative is the most common indication for using MV (38%), central nervous system disease (23%), and respiratory system disease (23%). Moreover, 13 patients from 206 patients (6.3%) using MV developed complication and Ventilator-associated pneumonia (VAP) being the most common cause of it (4.8%) (Zahrah, 2018). From the research conducted at Aga Khan University Hospital, Pakistan, stated that 605 patients were admitted to PICU and 307 (50.7%) of them received MV for more than 24 hours. The leading causes for MV in PICU are divided into four major categories including acute neurological illness (35.8%), respiratory illness (20.8%), cardiac failure (13%), and miscellaneous group (30.3%) (Mukhtar et al., 2014). While another study held at Cairo University Pediatric Hospital, 893 patients were admitted to PICU and 293 patients were ventilated. Neurological disease is the most common cause of MV (Salah Meligy et al., 2017).

The conclusion about all of the evidences above is that admission and treatment of critically ill pediatric admitted to PICU especially the usage of mechanical ventilator in developing counties is crucial. Yet information and data needed regarding PICU and Mechanical Ventilator are very hard to find (Seifu et al., 2022). It also supported by other research, held in Jimma University Specialized Hospital (JUSH), Ethiopia. Unlike in developed countries that death before discharge is a rare outcome, in developing countries there are only few data about children's critical care in PICU. Because of lacking in data resources, it is difficult to make improvement of outcome and provision of aid for the patient (Burns et al., 2014).

Because Indonesia is also a developing country, the lack of data and journals discussing about PICU in Surabaya, especially about MV in PICU become the background of this research.

METHOD

This research included a quantitative research study with a descriptive retrospective method using medical records of the patients. This research was conducted from January 2021 to December 2022 using the physical medical records and electronic medical records at PICU RSUD Dr. Soetomo Suarabaya. The data were processed using Microsoft Excel software. This research is conducted after obtaining permission and approval from the Research Ethics Committee of Faculty of Medicine Universitas Airlangga and the Research Ethics Committee RSUD Dr. Soetomo Surabaya with ethical number 2568/105/3/XI/2023.

Table 1. Inclusion and Exclusion Criteria

Inclusion	Exclusion
• Children patient with age ranging from 1 month – 17 years old	Patients with incomplete medical records
• The usage of invasive MV and non-Invasive MV	Patients that already intubated before admitted to PICU
• Patients with medical or surgical indications for PICU	Patient that didn't using MV
	Patients admitted to PICU less than six hours

RESULT

Demographic Aspect

Demographic Aspect of Patients using MV in PICU RSUD Dr. Soetomo Surabaya consist of the patient's gender, age and nutritional status. From January 2021 until December 2022, it was found that the majority of patient treated in PICU and using MV are male with numbering 64 patients (57.66%).

Table 2. Patient's Gender Using MV in PICU

Gender	n	%
Male	64	57.66
Female	47	42.34

Based on the data obtained, in 111 patients that were using ventilator, most of the patient, 55 patients (49.55%) were categorized as infants with age ranging from 1 month old to 12 months old.

Table 3. Patient's Age Using MV in PICU

Age Group	n	%
Infants (1-12 months)	55	49.55
Children (>1-12 years)	50	45.05
Adolescent (13-17 years)	6	5.41

From 111 patients, there are 65 medical records (58.56%) with complete data about patient's weight and height. Based on WHO and CDC indicators, the nutritional status is divided into two main categories which are nutritional status for children under 5 years old and nutritional status for children between 5 to 17 years old. The majority of the patients based on the data that already processed are 35 patients (53.84%) are in wasted nutritional status. Moreover, there are 21 patients in infants age group were having wasted nutritional status.

Table 4. Patient's Nutritional Status Using MV in PICU

Nutritional Status	Age Group			n (n=65)	%
	Infants	Children	Adolescent		
Wasted	21	12	2	35	53.84
Normal	9	11	2	22	33.85
Overweight	0	5	0	5	7.69
Obese	0	3	0	3	4.62

Indication of Admission

From the data that has been taken and processed, it is found that, from 111 inclusion patients, there are 46 patients (41.44%) with respiratory problems admitted to PICU and treated using MV. The majority of patients admitted to PICU caused by respiratory problems are infant patients numbering 24 patients out of 46 patients.

Table 5. Indication of Patients Admission

Indication of Admission	Age Group			n	%
	Infants	Children	Adolescent		
Respiratory System	24	20	2	46	41.44
Neurology System	11	11	0	22	19.82
Cardiovascular System	7	4	2	13	11.71
Gastrointestinal and Hepatobiliary System	4	3	0	7	6.31
Hematology and Onclogy	1	5	1	7	6.31
Endocrine and Metabolic System	4	2	0	6	5.41
Surgery	3	3	0	6	5.41
Kidney and Urinary Tract	1	2	1	4	3.60
Musculoskeletal System	0	0	0	0	0

Mode of Mechanical Ventilation

Based on the medical record that has been obtained and processed, 77 patients (69.37%) are using MV with PSIMV/SIMV mode as the majority used at RSUD Dr. Soetomo Surabaya. From this result it is found that 38 patients from infants age were using MV with PSIMV/SIMV mode.

Table 6. Mode of MV Used in PICU

Mode of Ventilation	Age Group			n	%
	Infants	Children	Adolescent		
PSIMV/SIMV	38	34	5	77	69.37
PCV	11	5	0	16	14.41
DUOPAP	1	2	1	4	3.60
A/C	2	1	0	3	2.70
BILEVEL	1	4	0	5	4.50
nCPAP	2	1	0	3	2.70
CPAP	0	2	0	2	1.80
ASV	0	1	0	1	0.90

DISCUSSION

The Demographic aspects of patients using MV in PICU RSUD Dr. Soetomo Surabaya are supported by several research done in other countries. In this research, it is found that the most dominant sex of patient treated at PICU RSUD Dr. Soetomo Surabaya and using MV are male. There are 64 male patients (57.66%) from January 2021 until December 2022. It is in line with the research that was conducted by Bacha et al. (2021) which states that the majority of the patient treated in PICU using MV at Ethiopia were males. Moreover, another research carried out in India also stated that 76 patients (75.2%) from a total of 101 patients

admitted to PICU and using MV were male (Sahoo et al., 2018). From another research conducted by Durak & Boydag Guvenc in Istanbul, Turkey, it is also stated that from 139 patients were analyzed, of which 79 (56.8%) were males (2023). Therefore, another similar study done in 2017 showed that the majority of patient treated in PICU and using MV at RSUD Dr. Soetomo Surabaya were female (Aina et al., 2020). According to Thurstans et al. (2020), it is showed that male children had higher risk to be wasted, stunted, and being underweight than female children. Moreover, malnutrition children are evidenced to require mechanical ventilator more than normal children (Teka et al., 2022b). However, another study done in PICU at United Kingdom stated that the majority of patients admitted to PICU were male, but female patients had higher rate of mortality in PICU (Almossawi et al., 2021).

Moreover, from this research, it is revealed that the most common age group using MV at PICU RSUD Dr. Soetomo is infants age group, ranging from 1 month old to 12 months old. There are 55 infant patients (49.55%) and 50 children (45.05%) from January 2021 until December 2022. There are only 6 patients (5.41%) from adolescent age group. Another research held at PICU RSUD Dr. Soetomo stated that from September 2019 to February 2020, the majority of the patient are infants under one year old (Prasanty et al., 2021). It is also supported by research held in Nepal which revealed that the total of patient with age under 1 year old (38.6%) is greater than other age group (Bastola et al., 2023). However, from January until December 2017, infant and toddler are the most common age group treated at PICU RSUD Dr. Soetomo with number of patients in each age group are 7 patients (Aina et al., 2020).

In addition, another study stated that most of children admitted to PICU under 2 years old were the same patients who had previously been treated for in Neonatal Unit (NNU) (Seaton et al., 2024). Moreover, it is found that preterm-born children have a higher risk for using invasive MV to support their respiratory system (van Hasselt et al., 2023). From this research, it is also showed that most of the patient who use ventilator in PICU at RSUD Dr. Soetomo Surabaya are in wasted nutritional status numbering 35 patients (53.84%). Moreover, there are 21 patients in infants age group were having wasted nutritional status. Moreover, there are 3 patients (4.62%) were in obese nutritional status. Both wasting and obesity are considered as the primary forms of malnutrition (Zhang et al., 2021).A study done in Turkey, regarding nutritional status of children treated at PICU, found 279 patients (45.4%) of 614 patients were admitted to PICU with malnutrition nutritional status (Misirlioglu et al., 2023).

Research done by Gwela et al. (2019) stated that children with malnourished status are more prone to suffered from critical ill than children with normal nutritional status. It is happened because malnourished children had bad gut barrier function that causing the host immunity being more vulnerable to get infected. Moreover, Bechard et al. (2016) stated that children with underweight or obese nutritional status were having higher rates of hospital-acquired infections than children with normal nutritional status. Furthermore, according to Teka et al. (2022), children with malnutrition are tend to require mechanical ventilator than children without malnutrition. Another research also stated that children with malnutrition also have longer duration of using MV than children without malnutrition. Those children had higher risk of mortality and morbidity in PICU. Because of that, it is important to access nutritional status of a child on admission to prognosticate the outcome of the patient in PICU (Samanta et al., 2022).

This research found that the majority of the patients were admitted to PICU because of respiratory problems. From 111 inclusion patients, there are 46 patients (41.44%) with respiratory problem, followed by neurology system problem as the second most common cause of patient admitted to PICU with 22 patients (19.82%) having the problem. This number also supported by other research that states respiratory cases as the majority

indication of MV usage and significant cause of mortality with rates reaching as high as 50% (Kollisch-Singule et al., 2022). Another study done in the Sancaktepe Sehit Prof. Dr. Ilhan Varank Training and Research Hospital in Turkey also found that the most common underlying cause of ventilated children were respiratory disease, 54 patients (38.8%), followed by sepsis (22.3%) and neurological disease (12.9%) (Durak & Boydag Guvenc, 2023). On the other hand, research done by Liu et al. (2022) stated that the second most common underlying cause of MV is acute circulatory system disease (26%) then followed by acute neurological disease (15%) as the third common underlying cause of ventilated children. It is known that respiratory problems are the most common cause of MV usage in children because their respiratory organ are still not fully developed yet (Sood et al., 2023). However, another study done in England and Wales found out that the main cause of children born at term admitted to PICU were because of cardiac condition. Meanwhile, the main cause of children born preterm admitted to PICU were because of respiratory condition (Seaton et al., 2024) Furthermore, it is also known that the usage of ventilator is able to support children with acute and complex diagnose in PICU by providing the highest support in respiratory system (Anitha et al., 2016). Ventilator usage is proven to support respiratory system of patients by allowing better gas exchange (MacDonald et al., 2024).

The results showed that out of 111 inclusion patients, 77 patients (69.37%) are ventilated using mechanical ventilated with PSIMV/SIMV mode at RSUD Dr. Soetomo Surabaya. Followed by PCV as the second most common mode (14.41%) used in MV and ASV is the least used (0.90%) mode in MV at PICU. There is a little difference with research done in Tikur Anbessa Specialized Refferal Hospital, Ethiopia, which found out that SIMV was the most commonly used mode in MV. It is mentioned that some country such as Turkey, Pakistan, Egypt, India, and Bangladesh also commonly use SIMV mode for ventilation(Bacha et al., 2021). Previously, SIMV mode in ventilator is only used to wean patients after using MV. However, it is showed that SIMV able to avoid placing a mechanical breath on top of spontaneous breath(Wolf, 2007). Moreover, SIMV and SIMV-PS are providing many benefits for the patient, including reduced work of breathing, improved patient comfort while using ventilator, reduced ventilator asynchronies, and eased patient through ventilator weaning (Lazoff & Bird, 2023).

The majority of male patient treated in PICU using MV is in line with the research that was conducted by Bacha et al. (2021) which states that the majority of the patient treated in PICU using MV at Ethiopia were males. According to Thurstans et al. (2020), it is showed that male children had higher risk to be wasted, stunted, and being underweight than female children. Moreover, malnutrition children are evidenced to require mechanical ventilator more than normal children (Teka et al., 2022). Data about the majority of the patient treated in PICU using MV are in infants age group also supported by research held in Nepal which revealed that the total of patient with age under 1 year old (38.6%) is greater than other age group (Bastola et al., 2023). Another study stated that most of children admitted to PICU under 2 years old were the same patients who had previously been treated for in Neonatal Unit (NNU) (Seaton et al., 2024). In another research, it is found that preterm-born children have a higher risk for using invasive MV to support their respiratory system (van Hasselt et al., 2023). From this research it is found that the majority of children patients treated in PICU using MV in RSUD Dr. Soetomo are infants with wasted nutritional status. Research done by Gwela et al. (2019) supported those findings, that children with malnourished status are more prone to suffered from critical ill than children with normal nutritional status.

After the data obtained, it is found that the most common cause of admission to PICU is because of respiratory problems. It is also supported by other research that states respiratory cases as the majority indication of MV usage and significant cause of mortality with rates reaching as high as 50% (Kollisch-Singule et al., 2022).It is known that respiratory problems

are the most common cause of MV usage in children because their respiratory organ are still not fully developed yet (Sood et al., 2023). Furthermore, the majority of the patient were using MV with mode PSIMV or SIMV because it is found that those mode are providing many benefits for the patient, including reduced work of breathing, improved patient comfort while using ventilator, reduced ventilator asynchronies, and eased patient through ventilator weaning (Lazoff & Bird, 2023).

CONCLUSION

Based on the research, it is found that the majority of the patients treated in PICU and using MV had demographic aspects of the following, most of the patients were male, in the infants age group ranging from 1 month old to 12 months old, and most of the patients were having wasted nutritional status. The majority of the patients were treated in PICU because of respiratory problems and the majority of the patients were using MV with PSIMV/SIMV mode.

The limitation is caused by some data were unavailable both from the manual records and also the electronic medical record. The author suggests that doctors and health professionals, do a complete history taking such as height and weight of the patients, as such information are hard to come by in the medical records as of this research. Don't forget to make the early nutrition assessment to make relevant information easily searchable. To future researchers and students, create analytical and prospective research to know more about the correlation between patient's age, indication of ventilator usage, duration of ventilator usage, and the outcome of the patients in PICU RSUD Dr. Soetomo Surabaya.

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