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Demographic Profile of Nosocomial Pneumonia in the PICU at the Tertiary Hospital in Surabaya

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ABSTRACT

Introduction: Pneumonia is one of the most common nosocomial infectious diseases, especially in developing countries. Resistant microorganisms usually cause HAP and VAP. Utilizing supporting factors such as age, gender, and underlying diseases as a basis for clinical decision-making is one of the strategies to prevent nosocomial infections, especially HAP and VAP. ***Objective:*** To find out the demographic profiles of HAP and VAP in the PICU of Dr. Soetomo General Hospital. ***Methods:*** Retrospective descriptive study using medical record data. ***Results:*** A total of 31 patient medical records were obtained, which will be used in this study. The most common occurrence is VAP. The most common gender is female. The most common age was patients less than 1 year old. The most common underlying diseases were infections and congenital disorders. ***Conclusion:*** The incidence of HAP and VAP in the PICU of RSUD Dr. Soetomo was 26.5% of the total sample obtained. Most cases were dominated by VAP, which was 18 cases. The most common gender obtained was female. The most common age found was in infants less than 1 year and also toddlers.

Keywords: HAP; VAP; PICU.

INTRODUCTION

Pneumonia is a lung inflammation caused by infection with microorganisms such as bacteria, viruses, and fungi [1]. Inflammation causes the alveolus to be filled with pus and liquid, resulting in reduced oxygen supply and pain while breathing. Worldwide, pneumonia is one of the deadliest diseases, and 14% of those who die are children under five years old [2]. In developing countries, pneumonia is a common disease and a frequent cause of death, especially among children [3]. In Indonesia, childhood pneumonia cases also contribute to higher rates of morbidity and mortality [4].

Hospital-acquired infection (HAI) cases remain prevalent in developing countries. Therefore, effective infection control practices and strict supervision are essential to improve patient safety and reduce the incidence of HAIs [5]. The incidence of HAI is one of the key indicators used to evaluate hospital performance [6]. HAIs are often caused by microorganisms that are resistant to antibiotics [7]. This resistance requires stronger or a combination of antibiotic therapies [8]. The bacteria that cause hospital-acquired pneumonia (HAP) are considered more virulent because many of them are resistant to multiple antibiotics [9]. Furthermore, ventilator-associated pneumonia (VAP) is reported as one of the leading HAIs contributing to high morbidity and mortality rates in pediatric intensive care units (PICUs)[10].

The occurrence of VAP and HAP infections can significantly impact both patients and their families [11]. One of the consequences is the increased burden of hospitalization costs and the need for long-term medication use [6]. Effective implementation of infectious disease prevention protocols is essential [12]. Utilizing supporting factors such as age, gender, underlying diseases, and differences in hospital wards as a basis for clinical decision-making is one of the strategies to prevent nosocomial infections [6]. Although numerous studies on nosocomial infections have been conducted at Dr. Soetomo General Hospital, very few have focused exclusively on the PICU. In this study, the researcher aims to examine the aspects of age, gender, and underlying diseases in patients with HAP and VAP in the PICU of Dr. Soetomo General Hospital, Surabaya.

METHOD

This study is a retrospective descriptive study utilizing medical records of HAP and VAP pneumonia patients admitted to the PICU of Dr. Soetomo General Hospital. The sampling method used was total sampling, involving all PICU patient records from January 2022 to December 2023. Inclusion criteria are patients diagnosed with pneumonia. Exclusion criteria are patients diagnosed with pneumonia other than HAP or VAP, as well as those without any microbial laboratory results. Data meeting the criteria were grouped based on predetermined variables. The data were processed using Microsoft Excel and presented in the form of frequency distribution tables, then analyzed using descriptive methods. This study received ethical approval from the Health Research Ethics Committee of Dr. Soetomo General Hospital, with approval letter number 1648 / LOE / 301.4.2 / IV/2024. Patient names were anonymized using initials, although medical record numbers were documented to ensure data validity. All obtained information will be kept confidential and used solely for research purposes, with no data shared with external parties.

TABLE 1: Demographic Data Distribution.

Demographic Data	Total (n=31)	HAP (n=13)	VAP (n=18)
	n (%)	n (%)	n (%)
Gender (Male)	14 (45,2)	4 (37,8)	10 (55,5)
Infant and Toddler Age (0-5 years)	23 (74,2)	9 (69,2)	14 (77,8)
Infant (<1 year)	13 (41,9)	5 (38,5)	8 (44,5)
Underlying Disease	51(100)	23 (45,1)	28 (54,9)
Infection	16(31,4)	5(21,7)	11(39,3)
Congenital Disorders	11(21,6)	4(17,4)	7(25,0)
Neurological Disorders	5(9,8)	3(13,0)	2(7,1)
Hematologic Disorders	4(7,8)	3(13,0)	1(3,6)
Renal Disorders	3(5,9)	2(8,7)	1(3,6)
Body Balance Disorders	2(3,9)	2(8,7)	0(0,0)
Autoimmune Disorders	2(2,9)	1(4,3)	1(3,6)
Endocrine Disorders	1(2,0)	1(4,3)	0(0,0)

RESULT AND DISCUSSION

A total of 106 samples were obtained from the electronic medical records database. A total of 31 samples were extracted after being filtered using the inclusion and exclusion criteria, with the distribution as shown in Table 1.

In this study, the incidence of HAP and VAP in girls was 54.8%, which was higher than in boys. This finding is in line with the opinion of Mairuhu et al., who stated that women are more at risk of infections that can lead to death [13]. However, different results were found in a study conducted by Vijay et al., which reported that the incidence of VAP was more prevalent in men. Their study also stated that no statistically significant differences were observed [14]. Research by Nurhayati et al. suggested that gender differences may influence the incidence of pneumonia infections. However, in terms of treatment, there is still no significant difference [15]. Several studies on adults show that mortality is higher in female patients. Factors for this pattern are many and spread across all aspects. Aspects such as old age and pre-existing comorbidities. Females may also have increased humoral immunity compared to males. As mortality in pneumonia is often correlated to that of the inflammatory response of the immune system, this may be an important factor in mortality incidences [16,17]. Social health behavior also plays a role in delayed medical attention, as males seldom seek help while sick compared to females [17].

Based on age group, this study found that cases of HAP and VAP pneumonia infections in the PICU were predominantly found in infants under 1 year old (41.9%), with incidences decreasing as they grow older. This finding is consistent with research conducted by Nurhayati et al. in the pediatric ward of Dr. Soetomo General Hospital, which reported that many HAP cases occurred in children under five years old [15]. Infants under 1 year of age experience a decline in maternal immunity and begin developing their own immune responses. During this period, normal flora, physical barrier functions, and IgM production are still immature, making them highly susceptible to simultaneous infections by various pathogens [18]. A study conducted by Bhattacharya in India found that the incidence of VAP in the PICU was most prevalent among patients aged 1–5 years. However, according to the study, there was no statistically significant association between age and the incidence of VAP ($p = 0.314$) [19]. Similarly, Ericson argued in his study that as children grow older, there is a slight increase in the likelihood of acquiring nosocomial pneumonia. However, this is influenced by many other risk factors [20]. As an intrinsic risk factor for healthcare-associated infections (HAIs), age cannot be modified; however, improved care management in pediatric patients can help prevent HAIs [21].

A longer stay in the PICU often indicates a more severe illness. Prolonged hospitalization in the PICU also increases the risk of healthcare-associated infections (HAIs) [22]. A study conducted in a hospital in Taiwan reported that conditions such as being under one year of age, having a history of CHD, being born prematurely, experiencing respiratory disorders, and having abnormal white blood cell counts and C-reactive protein (CRP) levels are risk factors for admission to the PICU. CRP itself is a marker of bacterial infection and is associated with the incidence of pneumonia in children [24]. Children admitted to the PICU are typically in critical condition, with many experiencing severe pathophysiological disturbances and weakened immune systems [18]. In this study, the most common reason for PICU admission was infection (31.4%), followed by congenital disorders (21.6%). Neurological disorders (9.8%) and other conditions (13.7%) were also noted. In a separate study conducted in a PICU in Nepal, the incidence of infection (11.3%) was also identified as a cause of admission. However, it was lower than the incidence of neurological disorders (33%) and respiratory disorders (38%) [20]. The most common infectious diseases identified were community-acquired pneumonia (CAP) and meningitis.

Some patients were also found to have congenital disorders such as congenital heart disease (CHD), respiratory tract atresia, and Down syndrome.

Neurological disorders can impair respiratory function and suppress the vomiting reflex, increasing the risk of aspiration. This condition makes children more susceptible to hospital-acquired pneumonia (HAP) or ventilator-associated pneumonia (VAP) [20]. In patients with neuromuscular disease, pneumonia often occurs due to aspiration, impaired cough reflex, and atelectasis. These complications arise from weakened respiratory muscles, leading to shortness of breath and acute hypercapnia [25]. Patients with neurologic disorders have an increased risk of VAP due to prolonged intubation or impaired respiratory mechanics due to nervous system impairment [26]. Immunologically, patients with brain injury experience increased production of chemokines, proinflammatory cytokines, and cell adhesion molecules. These cytokines function to clear cellular debris in the central nervous system (CNS) after injury and initiate an inflammatory response. However, if this inflammatory response becomes persistent, it may lead to immune system dysregulation, which is one of the risk factors for developing pneumonia [29].

TABLE 2: Description of Underlying Disease.

Category	Description
Autoimmune Disorders	Lupus Nephritis
Endocrine Disorders	Hypothyroid
Renal Disorders	Bilateral Renal Multiple Nephrocalcinosis, Renal Failure, Nephrotic Syndrome
Hematologic Disorders	Leukemia, Dengue Fever, Anemia
Cardiac Disorders	Right Heart Failure, Mitral Regurgitation
Body Balance Disorders	Acute Diarrhea, Vomiting, Dehydration
Congenital Disorders	Down Syndrome, Esophageal Atresia, Atresia Ani, Laryngomalacia, Tracheoesophageal Fistula, Cerebral Palsy, Congenital Heart Disease (ASD, VSD, PDA), Developmental Delay
Neurological Disorders	Epilepsy
Infections	CAP, Meningitis, Ventriculitis, Encephalitis, UTI, Sepsis, Tetanus, Toxoplasmosis Congenita
Other Disorders	Hyperbilirubin, Tumor, Low Birth Weight, Multiple Organ Dysfunction Syndrome, Aspiration Pneumonia

A study about the prevalence of pneumonia in patients with congenital heart disease (CHD) conducted in a tertiary hospital in India reported that 12.5% of pediatric pneumonia patients had CHD. Anatomically, cardiac deformities in children with CHD can lead to hemodynamic disturbances in the lungs, thereby increasing the risk of lower respiratory tract infections. However, the severity and progression of such infections require further investigation [23]. A study at the pediatric inpatient ward of Dr. Soetomo General Hospital, Surabaya, found that several factors significantly influenced the mortality rate of pneumonia in children with left-to-right shunt congenital heart disease (CHD).

These factors include defect size, oxygen desaturation, first antibiotic replacement, and pulmonary hypertension. Children with medium to large CHD defects were found to be eight times more likely to die compared to those with minor defects. [27]. In a study about the incidence of pulmonary hypertension in patients with atrial septal defect (ASD), it was found that minor defects (such as VSD < 1 cm or ASD < 2 cm) may provide benefits for certain patients with pulmonary arterial hypertension [28]. This can happen because the presence of a shunt allows blood to bypass the lungs and flow directly into the systemic circulation, thereby reducing pressure in the right ventricle and helping to stabilize cardiac output [27].

The use of invasive devices such as endotracheal tubes (ETTs) and mechanical ventilators can compromise the body's natural defense barriers, providing a direct route for pathogens to enter and proliferate. Additionally, the use of broad-spectrum antibiotics may contribute to increased resistance among normal flora and specific pathogens [18].

CONCLUSIONS

The incidence of HAP and VAP in the PICU of RSUD Dr. Soetomo was 26.5% of the total sample obtained. Most cases were dominated by VAP, which was 18 cases. The most common gender obtained was female. Gender differences can affect the incidence of infection, but in the treatment, there is no effect. The most common age found was in infants less than 1 year and toddlers. This can be explained because at that age, the immune system is not well formed, so it will be more susceptible to cases of HAP and VAP. Infectious diseases and congenital disorders are the most common underlying diseases. Infectious events trigger a prolonged inflammatory response that leads to immune system dysregulation. In neurological diseases, there may be weakness of the body muscles, causing difficulty in breathing and a risk of aspiration. In pneumonia patients with CHD, mortality rates depend on the size of the defect. These conditions often require patients to be placed on mechanical ventilators, thereby increasing the incidence of VAP and HAP. Comorbidities, sources of infection, and health-related behaviors strongly influence the incidence of HAP and VAP infections. Each institution needs more in-depth research regarding nosocomial infection agents and their influencing factors.

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