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Incidence of Respiratory Tract Infection in Children with Cyanotic and Acyanotic Congenital Heart Disease: A Comparative Study

Syafira Yasmine[1], I Ketut Alit Utamayasa[2*], Bambang Herwanto[3]

[1]Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.
[2]Department of Pediatrics, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.
[3]Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.

ABSTRACT

Introduction: Respiratory tract infection (RTI) is the leading cause of children mortality rate in the world. Congenital heart disease (CHD) is a common congenital disease that plays a role in RTI incidents. However, between the 2 types of CHD, which type that is more potential to cause RTI is not well identified. The aim of this study was to compare the incidence and hospitalization time of RTI between 2 types of CHD and describe the profile of the patients based on gender, age, nutrition, and immunization status.

Methods: This retrospective study identified the medical records of children with RTI and all types of CHD aged 0-18 years old at Dr. Soetomo General Hospital Surabaya. The diagnosis of CHD was observed by echocardiography and RTI was observed by clinical symptoms.

Results: Of 135 patients, the incidence of RTI showed no difference between a patient with cyanotic and acyanotic CHD. The majority of the patient was aged less than 3 years old (93.3%) and dominated by male patients (53.3%). The frequency of children with severe underweight and good nutritional status was equal. There were 85 patients who had incomplete immunization based on their age. The most common type of acyanotic CHD was an atrial septal defect (ASD). Cyanotic CHD was dominated by the tetralogy of Fallot (ToF). Pneumonia was the common type of RTI (108/135). RTI patients with acyanotic CHD had a longer time of hospitalization than cyanotic patients (11 days).

Conclusion: This study found that RTI patient with acyanotic CHD experienced longer hospital lengths of stay.

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* Correspondence: ketut.alit.utamayasa@fk.unair.ac.id

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Introduction

Respiratory tract infection (RTI) is one of the health problems in the world. Its mortality cases reach 2 million people in all age groups. Lower RTI is the main cause of death in children <5 years old.[1] One of the predisposing factors for RTI is congenital heart disease (CHD). Patient with CHD has a 2-fold risk of recurrent RTI within 1 month.[2]

CHD is the most common congenital disease, at least each year there are 32,000-40,000 cases in Indonesia.[3] The imbalance between the need and distribution of oxygenated blood due to chronic CHD and environmental exposures such as weather and high virulence of pathogens that cause RTI will increase the body's susceptibility to RTI.[4] The presence of a history of CHD affects the severity and hospitalization time of patients with RTI. The mortality rate of pneumonia increased 24 times fold in patients with a history of CHD.[5]

Children are easier to get infected due to their inadequate immunity due to many factors, such as malnutrition, history of cardiovascular, and cerebrovascular disease. In immunocompromised children, lack of immunization and gender are related to inflammatory reactions.[6]

Previous studies explained that RTI is more common in children with acyanotic CHD, particularly the ventricular septal defect (VSD) subtype.[2,7] The potential risk of RTI in a patient with all types of CHD was not clearly identified. Therefore, this study aimed to compare RTI incidence and hospitalization time of patients with cyanotic and acyanotic CHD and observe the risk factors in patients based on age, gender, nutrition, and immunization data. Hopefully, this study will increase parents' awareness about RTI incidence and management in patients with CHD, as well as bring a better quality of life.

Methods

This retrospective study was conducted at Pediatric Clinic Dr. Soetomo General Hospital Surabaya between September 2020 and March 2021. All of the data was obtained from medical records of hospitalized RTI and CHD patients from 2018 until 2020. RTI patients with CHD history aged 0-18 years old were enrolled in this study. This study identified 7 variables: age, gender, nutritional status, immunization status, hospitalization time, and distribution of CHD and RTI incidence.

Some variables such as CHD, RTI incidence, and hospitalization time were analyzed with Fisher Exact test and Mann-Whitney test. Characteristics of the patients were presented in a table. This study had ethical approval from Dr. Soetomo General Hospital with number 0201/LOE/301.4.2/XI/2020.

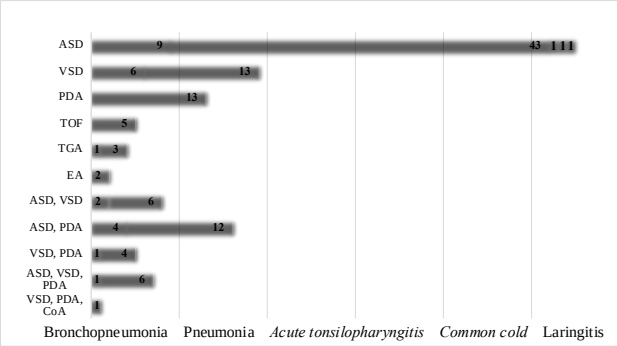
Results

The study had a total subject of 135 patients of children with CHD and RTI.

Table 1. Characteristics of the patients

Variable	n (%)
Gender	
Male	72 (53.3%)
Female	63 (46.7%)
Age	
0 - < 3 years old	126 (93.3%)
3 - < 6 years old	2 (1.5%)
6 - < 9 years old	1 (0.7%)
9 - < 12 years old	2 (1.5%)
12 - < 15 years old	3 (2.2%)
15 - 18 years old	1 (0.7%)
Nutritional status	
Severe underweight	44 (32.6%)
Underweight	37 (27.4%)
Normal	44 (32.6%)
Overweight	8 (5.9%)
Obesity	2 (1.5%)
Immunization status	
Complete	50 (37%)
Incomplete	85 (53%)

Table 1 shows that male patients had larger distribution than female patients. Patients aged <3 years was the largest population in this study. Most patients with CHD and RTI had severe underweight but also normal nutritional status. 53% of the patients had incomplete immunization.



Graphic 1. Incidence of RTI and CHD in Dr. Soetomo General Hospital

Graphic 1 shows that the largest case of RTI was pneumonia (108/135). CHD was dominated by atrial septal defect/ASD (55/135). Meanwhile, cyanotic CHD was dominated by the tetralogy of Fallot (ToF).

Table 2. Comparative study on incidence of RTI between CHD subtype

	Cyanotic CHD	Acyanotic CHD	p-value
Upper Respiratory Tract Infection	0	3	*1.00**

Lower Respiratory Tract Infection	11	121

***Fisher Exact test**

Table 2 shows that incidence of RTI was found larger in patient with acyanotic CHD. Based on Fisher Exact test from each CHD subtype, there were no difference between patient with acyanotic and cyanotic CHD ($p > 0.05$).

Table 3. Comparative study on hospitalization time of RTI patient with each CHD subtype

Hospitalization time (days)	Mean	Minimum	Maximum	p-value
RTI patient with cyanotic CHD	6	1	17	*0.03**
RTI patient with acyanotic CHD	11	2	56	

***Mann-Whitney test**

RTI patients with acyanotic CHD needed a longer time of hospitalization (11 days) than patients with cyanotic CHD. It was clearly approved by the Mann-Whitney test ($p < 0.05$).

Discussion

Characteristics of the Patients

The majority of RTI is experienced by children. It is the most significant cause of child mortality in the world, especially in children <3 years old who have inherited immunity from the mother, hence the body's immunity function is less than optimal with high environmental exposure.[8] The previous studies at Dr. Soetomo General Hospital and in Egypt showed similar results.[9,10] 53% of the study population were males. Inflammatory responses such as Interleukin 17-A, Chemokine ligand CXCL-1, CXCL-2 are more easily triggered in male mice, especially when infected with *Klebsiella pneumoniae*.[11] Environmental exposure and higher level of mobility in males make them susceptible to pathogens that cause RTI.[8] However, other studies stated that females are more prone to CHD because the diameter of the blood vessels is smaller. Furthermore, minimal levels of testosterone play a role in inflammation process, mainly due to influenza infection.[2,9,12]

Malnutrition is caused by several things. Increased needs due to clinical symptoms and co-infections such as RTI and other complications with an adequate number of calories due to shortness of breath and dysphagia are aggravated by other comorbidities.[13] Breastfeeding is an effort to fulfill the nutritional needs of children <1 year old. Lack of breastfeeding is often complained about by the patient's parents. It is considered to have an effect on the occurrence of pneumonia.[6] Malnutrition will have an impact on the duration of recovery and disruption in the growth and development of children.[14]

The nutritional condition of children and their growth and development patterns are influenced by the family's social-economic conditions, hygiene, and parenting.[15] Middle to higher family social-economic groups have the ability to require the nutritional needs of children. A previous study at Dr. Soetomo General Hospital found that patients with RTI came from middle to upper socio-economic families.[16] This might underlie the existence of a well-nourished population group in this study.

Poor immunity also plays a role in increasing the incidence of RTI in children. One of the ways to increase immunity is through immunization. Patients who had complete immunization according to their age are less likely to suffer from RTI.[16] This is in line with the results of this study. 63% of the study population did not have complete primary immunization (Bacillus Calmette–Guérin/BCG, Diphtheria-Pertussis-Tetanus, Haemophilus influenza, measles) according to their age. Therefore, it affects the minimal body protection against RTI. Malnutrition is also considered to have an effect on incomplete immunization of children.[15]

Incidence of RTI and CHD

ASD was found to be the highest in this study. It is in contrast with the results of previous studies which proved that the common case was VSD.[2,7] Pulmonary edema easily happened in ASD patients.[17] It will trigger the emergence of RTI. RTI will be divided into 2 groups according to their location, namely the upper and lower RTI.[18] Upper RTI is divided into several diagnoses, such as tonsillopharyngitis, laryngitis, and the common cold. Meanwhile, the lower RTI is divided into bronchopneumonia and pneumonia. As shown in graphic 1, the population in this study was dominated by lower RTI patients, especially pneumonia. This is in line with previous studies which showed that the trend of the incidence of lower RTI was found to be increasing in children with a history of CHD.[2,7]

Physiologically, respiratory tracts and organs such as the nasopharynx, oropharynx, and lungs are non-sterile organs that contain secrets and mix easily with microorganisms from outside the body and other organs, hence the colonies are easy to form. The colonization will cause symptoms if there is a worsening of individual conditions, an increasing number of pathogens, and poor environmental conditions.[19] The result of this study is actually different from a study conducted at Hasan Sadikin Hospital in Bandung, the diagnosis was dominated by bronchopneumonia.[7] Other risk factors that can play a role in the occurrence of ISP, such as premature birth, breastfeeding patterns, vitamin A supplementation, and exposure to air pollution are socio-economic factors that have not been studied in this study.

Comparative Study of RTI Incidence between Each CHD Subtype

RTI incidence was not found to be significantly different between patients with cyanotic and acyanotic CHD, meaning that RTI can occur in all types of CHD ($p > 0.05$). This is in line with a study conducted in Sweden, the incidence of RTI increased in both types of CHD and the patients required intensive hospitalization.[20] Pathophysiologically, cyanotic CHD results in reduced oxygen-rich blood flow throughout the body, hence the patient will fall into a hypoxic state, whereas in acyanotic type, there is excessive blood flow to lungs and can cause pulmonary congestive. These two conditions, which are accompanied by small diameter size of the respiratory tract in children, will increase the risk of RTI.[16] Malnutrition is common in children with CHD. This condition will affect the patient's immune system. In addition to factors from the host, environmental exposure plays an important role. The more frequent exposure to pollutant substances, environmental conditions with poor sanitation, and living in an environment with temperatures that tend to be erratic, children are likely to have an influence on the potential for RTI.

Comparative Study of Hospitalization Time of RTI Patients between Each CHD Subtype

The duration of hospitalization is closely related to the clinical condition of the patient. Patients with CHD have complicated condition that require intensive care. In a previous study, it was explained that RTI patients underwent repeated hospitalization were known to have a history of CHD.[21] However, it stated that *Klebsiella pneumonia* infection increased through nosocomial transmission after cardiac surgery.[22] The results of this study found that patients with acyanotic CHD and RTI required 2 times fold longer duration of hospitalization. These results are in line with a study conducted in Turkey, patients with subtype VSD with complications of pulmonary congestion often underwent hospitalization due to RTI even though the risk of hospitalization in the pediatric intensive care unit (ICU) is much greater.[23]

Conclusion

RTI incidence can happen both in children with acyanotic and cyanotic CHD. The hospitalization time found longer in RTI patients with acyanotic CHD. High incidence of RTI was found in male patients aged <3 years old, who had severe underweight and good nutritional status. More than 50% of the study population had incomplete immunization.

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Conflict of Interest

The authors declared there is no conflict of interest.

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