

ORIGINAL ARTICLE

Factors Predicting the Length of Hospital Stay in Infants with Bronchitis at Bethesda Hospital, Yogyakarta

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ABSTRACT

Introduction: Bronchitis is a primary cause of hospitalization in toddlers due to acute respiratory infections (ARI). Hospitalization is particularly necessary in this age group because their immature immune systems render them highly vulnerable to complications such as respiratory failure and secondary infections. Elevated, inflammatory responses reflected by increased leukocyte counts necessitate close clinical monitoring and intensive care to prevent deterioration. Therefore, inpatient care plays a crucial role in ensuring the clinical stability and effective recovery of toddlers with bronchitis. This study analyzed the predictive factors influencing the length of hospital stay in toddlers with bronchitis treated at Bethesda Hospital, Yogyakarta.

Methods: This study employed a quantitative approach using an observational analytic method with a cross-sectional design. Data were collected from 90 medical records of 105 hospitalized toddlers aged 1-59 months due to bronchitis in 2023. Age, sex, nutritional status, hemoglobin (Hb) levels, and leukocyte count were the analyzed variables. The data were analyzed using Chi-square and logistic regression.

Results: Age and leukocyte count were significantly associated with the length of hospital stay ($p < 0.05$). Younger toddlers were more likely to experience prolonged hospitalization (adjusted odds ratio/OR=0.242), while an increased leukocyte count (leukocytosis) elevated the risk of a longer hospital stay (adjusted OR=4.137). Other variables, including sex, nutritional status, and Hb levels, did not significantly influence prolonged hospitalization.

Conclusion: Age and leukocyte count were predictive factors for the length of hospital stay in toddlers with bronchitis at Bethesda Hospital, Yogyakarta, in 2023.

INTRODUCTION

Respiratory diseases are among the leading causes of morbidity and mortality in children, particularly in low- and middle-income countries.¹ Acute respiratory infections (ARI), including bronchitis, remain a major contributor to childhood hospitalizations worldwide.² In Indonesia, ARI is a significant public health burden and consistently ranks among the top ten leading causes of morbidity in children.³

Bronchitis, an inflammation of the lower respiratory tract, has a global prevalence of 10-20% and reaches 25-30% in certain populations.^{4,5} Respiratory

syncytial virus (RSV) is the most common cause of bronchitis and bronchiolitis, accounting for over 3.6 million hospitalizations and nearly 100,000 deaths annually in children under five years old, with the majority in low- and middle-income countries.⁶ Hospitalization duration is an important indicator of disease severity and healthcare efficiency.⁷ Factors influencing length of stay include age, gender, nutritional status, hemoglobin (Hb) level, and leukocyte count.⁸⁻¹⁰ Younger children with immature immunity are more prone to severe disease and longer recovery.^{11,12}

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Given these significant impacts, it is essential to identify the predictive factors influencing the hospitalization duration in toddlers with bronchitis. While several studies have examined bronchitis in Indonesian toddlers, research specifically analyzing the factors that predict length of hospital stay remains limited. This study aimed to provide healthcare professionals with information to identify these predictive factors, thereby improving treatment effectiveness and reducing the burden of hospital care.

METHODS

This study used an observational analytical method with a cross-sectional design using the medical records of patients conducted at Bethesda Hospital, Yogyakarta, in January 2025, analyzing data from hospitalized toddlers aged 1-59 months diagnosed with bronchitis in 2023. Purposive sampling was used to collect samples based on the inclusion criteria. Using the Slovin formula with a 95% precision level ($\alpha=0.05$) from a population of 115 patients, a final sample size of 90 patients was calculated. Of the 115 medical records initially reviewed, 25 were excluded: nine due to non-bronchitis diagnoses, nine due to missing body weight data, and seven due to incomplete laboratory results.

The inclusion criteria were toddlers aged 1-59 months who were hospitalized at Bethesda Hospital, Yogyakarta, in 2023 with a diagnosis of acute bronchitis. The exclusion criteria were incomplete medical records, congenital diseases or congenital heart disease, critical condition, and referral to other hospitals during treatment. In this study, bronchitis was operationally defined as acute bronchitis, characterized by cough lasting 3 weeks, accompanied by clinical signs of lower respiratory tract infection, and without

radiological evidence of pneumonia. Patients with chronic bronchitis were not included.

Variables in this study included the dependent variable of length of hospitalization (categorized as short ≤ 4 days or prolonged >4 days) and independent variables of age (young toddlers: 1-12 months; older toddlers: 24-59 months), gender (female and male), nutritional status (good/better: ≥ -2 SD; poor/deficient: < -2 SD), leukocyte count (normal or leukocytosis), and Hb level (normal or anemia). Data analysis included univariate analysis for demographic descriptions, bivariate analysis using Chi-square tests to examine relationships between variables, and multivariate analysis using logistic regression to identify factors predictive of length of hospital stay.

This study obtained ethical clearance from the Ethics Committee of Bethesda Hospital, Yogyakarta (No. 68/KEPK-RSB/XII/24). All data extracted from the patients' medical records were used solely for research purposes, and confidentiality was maintained in accordance with ethical principles, including respect for persons, beneficence, and justice.

RESULTS

Data were obtained from the medical records of toddlers diagnosed with bronchitis at Bethesda Hospital, Yogyakarta, in 2023. The recorded data included the patient's medical record number, toddler age, gender, hospital admission and discharge dates, Hb and leukocyte count laboratory results, and the toddler's body weight.

Characteristics of Toddlers with Bronchitis

The frequency distribution and patient characteristics were based on the research results as follows:

Table 1. Frequency distribution of bronchitis in hospitalized toddlers in 2023

Variable	Frequency	Percentage (%)
Toddler Age		
Young toddler	36	40%
Older toddler	54	60%
Gender		
Male	49	54.4%
Female	41	45.6%
Nutritional Status		
Poor or undernourished	34	37.8%
Good or above	56	62.2%
Hemoglobin Level		
Anemic	8	8.9%
Normal	82	91.1%
Leukocyte Count		
Leukocytosis	17	18.9%
Normal	73	81.1%
Total	90	100%

Based on Table 1, the most toddler patients hospitalized due to bronchitis in 2023 were older toddlers (60%) with male gender (54.4%). Most toddler patients had a good or above nutritional status (62.2%), normal Hb levels (91.1%), and a normal leukocyte count (81.1%).

Relationships between the Variables

The relationships between variables in this study were analyzed to determine the influence of age, gender, nutritional status, Hb levels, and leukocyte count on the length of hospital stay in toddler patients with bronchitis. The Chi-square test was used with a significance level (p-value) <0.05 as the threshold for determining significant relationships.

Table 2. Relationship between variables and hospital stay length

Variable	Length of Hospital Stay		Total	p-value
	Short	Prolonged		
Toddler Age				
Young toddler	13	23	36	0.001*
Older toddler	40	14	54	
Gender				
Male	32	17	49	0.176
Female	21	20	41	
Nutritional Status				
Poor or undernourished	15	19	34	0.026*
Good or above	38	18	56	
Hemoglobin Level				
Anemic	1	7	8	0.008*
Normal	52	30	82	
Leukocyte Count				
Leukocytosis	4	13	17	0.001*
Normal	49	24	73	
Total	53	37	90	

*p-value <0.05 through the Chi-square test indicated significant results

A significant relationship was found between age, nutritional status, Hb level, leukocyte count, and length of hospital stay in toddlers with bronchitis.

Influence of Age, Nutritional Status, Hemoglobin Level, and Leukocyte Count on the Length of Hospitalization

Table 3. Relationship between age, nutritional status, hemoglobin level, and leukocyte count with the length of hospital stay

Variable	Regression Coefficient	p-value	Odds Ratio (95% Confidence Interval)
Toddler age	-1.421	0.017*	0.242 (0.076 – 0.772)
Nutritional status	-0.104	0.864	0.901 (0.274 – 2.967)
Hemoglobin level	1.719	0.144	5.579 (0.555 – 56.092)
Leukocyte count	1.420	0.037*	4.137 (1.086 – 15.762)

*p-value <0.05 through logistic regression test indicated significant results

DISCUSSION

Relationship between Age and Length of Stay in Children under Five Years Old with Bronchitis

This study showed that children aged under five years old were significantly associated with the length of stay in patients with bronchitis. Younger children (1-12 months) more frequently experienced prolonged hospitalization (25.5%) than older children (24-59 months) (15.5%). This study aligns with a previous study, stating that younger children have immature immune systems, particularly adaptive defense mechanisms such as specific antibody formation.¹³

Young children have high levels of T cells, but these T cells are still in a naive form, making them unable to respond effectively to antigen exposure during infection. This condition causes their bodies to be less capable of effectively fighting infections, thereby

increasing the risk of complications and prolonging the recovery time.¹⁰ In addition, another immunological factor contributing to the high incidence of bronchitis in young children, especially those under five years old, is suboptimal IgG levels, which slow down and make the body's response to pathogens less effective, requiring more intensive medical care.¹⁴

A previous study has shown that a child's immune system develops with age, with older children having more efficient immune responses in fighting infections, thereby accelerating the recovery process and reducing the length of hospital stay.¹³ This is due to the increased number and maturity of immune cells, such as T and B cells, as well as increased levels of immunoglobulins that play a role in the body's defense mechanisms. With more developed immune systems, older children can respond to infections more quickly, thereby accelerating the recovery process.¹⁴

Furthermore, better immune system effectiveness contributes to reducing symptom severity, lowering the risk of complications, and shortening the duration of hospital care.¹⁵

Relationship between Gender and Length of Stay in Children under Five Years Old with Bronchitis

This study found no significant relationship between gender and length of stay in children with bronchitis aged under five years. This finding differs from a previous study, which mentioned that boys were more susceptible to respiratory tract infections, including bronchitis, than girls.¹⁶ This susceptibility is associated with the influence of testosterone, which has immunosuppressive properties that can weaken the immune response in boys. In contrast, estrogen in girls is known to protect by increasing the activity of immune cells, such as T and B lymphocytes, which help fight infections.¹⁷

This study is similar to a previous study, stating that gender does not always have a significant relationship with the length of hospital stay.¹⁷ Both male and female children have the same possibility of length of stay. This may be due to other factors that have a greater influence on disease progression and the recovery process.¹ Several factors can affect the duration of hospitalization, including disease severity, complications during treatment, and the body's response to the therapy provided.¹⁸

The difference in results between this study and the theory may be due to several factors that have more significant influences, such as nutritional status and baseline health conditions, which have a more substantial impact on the length of stay.¹⁹ Additionally, environmental exposure and socio-economic factors may have similar contributions to the infection risk and duration of hospitalization.¹⁰

Relationship between Nutritional Status and Length of Stay in Children under Five Years Old with Bronchitis

Nutritional status is an important factor influencing the resistance of children under five years old to infections, including bronchitis, which impacts the duration of hospitalization.¹⁹ This study found a significant relationship between nutritional status and length of hospital stay, with children with poor or insufficient nutrition having longer hospital stays than those with good nutrition. This aligns with a previous study, stating that malnutrition can directly affect the body's ability to fight infections through various mechanisms, including decreased antibody production, weakened phagocytosis activity, and damage to mucosal barrier function.²

Children with poor nutritional status tend to experience prolonged inflammation, which can exacerbate clinical conditions.⁷ For example, deficiencies in protein and micronutrients such as iron, zinc, and vitamin A can weaken both innate and adaptive immune systems, thus prolonging the recovery process from bronchitis infection.⁶ Additionally, malnutrition often reduces the body's ability to repair tissue damaged by bronchitis inflammation.¹⁹ A previous study showed that children with poor nutrition have a higher risk of complications such as pneumonia, which requires longer and more intensive care.¹

Logistic regression analysis showed that nutritional status did not have a significant influence on the length of stay. This indicates that although nutritional status has a relationship with the length of stay in the bivariate analysis, it is not the main determinant of the duration of care. A previous study showed that although nutritional status affected the duration of hospitalization, its effect could be influenced by other factors, such as the patient's medical condition and inflammatory response to infection.¹⁹

Relationship between Hemoglobin Levels and Length of Stay in Children under Five Years Old with Bronchitis

Anemia, characterized by low Hb levels, is often associated with an increased risk of infection and longer recovery periods in children with bronchitis.¹⁵ This study showed that low Hb levels or anemia were significantly associated with the length of hospital stay, where children with anemia had a higher risk of experiencing longer hospital stays than children with normal Hb levels. This study is similar to a previous study, mentioning that chronic inflammation in respiratory tract infections can interfere with iron absorption, shorten erythrocyte lifespan, and worsen anemia.²⁰ This can be explained by the role of Hb in transporting oxygen to body tissues.²¹ When Hb levels are low, oxygen is delivered to body tissues and oxygen supply to vital organs becomes suboptimal, which can hinder the healing process and prolong inflammation due to bronchitis infection.^{4,21} Additionally, anemia can also weaken the immune response, making children more susceptible to secondary infections or prolonging the inflammatory process that occurs during bronchitis infection.¹⁹

Based on the logistic regression analysis, Hb levels were not a main predictor factor in determining the length of stay after controlling for other variables. Nevertheless, the relatively high OR showed that children with anemia still have a 5.579 times greater possibility of experiencing longer hospital stays than children with normal hemoglobin levels. This is

supported by a previous study, which showed that chronic iron inflammation due to respiratory tract infections can interfere with iron absorption and worsen anemia, thereby affecting the length of hospital stay.²¹

Relationship between Leukocyte Count and Length of Stay in Children under Five Years Old with Bronchitis

The leukocyte count is a primary indicator of the body's inflammatory response to infection.¹ In this study, leukocytosis, or an increased leukocyte count, was found to be significantly associated with the duration of hospital stay in children with bronchitis. Children experiencing leukocytosis have a greater possibility of longer hospital stays than children with normal leukocyte counts. These results align with a previous study showing that increased leukocyte counts are associated with the severity of clinical symptoms, such as high fever and increased secretion production in the respiratory tract, thus prolonging the duration of hospitalization.¹⁸

Leukocytosis reflects the body's response to severe infection.¹³ It plays a role in worsening bronchitis infection symptoms through excessive inflammatory responses.¹³ In bronchitis infections, especially those caused by bacteria or viruses, the body's immune system responds by increasing leukocyte production, particularly neutrophils, to fight pathogens.¹³ Significant increases in leukocyte counts can cause the release of proinflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF- α), which exacerbate inflammation in the respiratory tract.¹⁹ As a result, the bronchial walls become thicker and experience edema, narrowing the bronchial lumen and increasing excessive mucus production.¹³ This causes symptoms such as prolonged coughing, shortness of breath, and wheezing to become more severe, and increases the risk of airway obstruction that can slow the healing process.¹⁵ These findings align with a previous study, showing that children with uncontrolled leukocytosis have a higher risk of experiencing complications such as bronchopneumonia, which extends the duration of hospitalization.¹ In some cases, especially in children with immature immune systems, excessive inflammatory responses can cause more severe damage to the bronchial epithelium, increasing the risk of fibrosis or structural changes in the airways. This condition not only worsens the acute symptoms but also increases the likelihood of bronchitis recurrence in the future.¹⁵

In the logistic regression analysis, two variables were found to have a significant influence on the length of stay for children with bronchitis: the child's age and leukocyte count. The age of the child showed a negative

relationship with the duration of hospitalization, with a regression coefficient value of -1.421 and an OR value of 0.242, which means the possibility of experiencing prolonged hospitalization decreases as the child's age increases, namely 0.242 times that of a younger age. On the other hand, leukocyte count showed a positive relationship with the length of stay, with a regression coefficient value of 1.420 and an OR of 4.137, where an increase in leukocyte count (leukocytosis) increases the possibility of patients undergoing prolonged hospitalization, namely 4.137 times that of patients with normal leukocyte counts. This aligns with the theory presented in previous studies, which show that children under one year old have a high number of white blood cells (leukocytes), but these cells are less specific.¹⁰ Therefore, young children with high leukocyte counts (leukocytosis) tend to have less effective immune responses in fighting pathogens, which can affect their recovery process and hospital care.

Leukocytosis is more common in children, especially those under one year old, because their immune systems are still in the developmental stage. At this age, the immune system exhibits certain characteristics that distinguish it from that of adults, including increased bone marrow activity in producing leukocytes as a compensatory mechanism for the limitations of the adaptive immune system. Children under one year old have a more dominant innate immunity than their adaptive immune system, which is still in the maturation stage. This occurs when they are exposed to new pathogens not yet recognized by the body. The innate immune response will be more dominant, characterized by increased neutrophil, monocyte, and macrophage production as the first line of defense.¹⁷

The mechanism of leukocytosis in young children begins with the detection of pathogens by innate immune cells, such as macrophages and dendritic cells, which then release various proinflammatory cytokines, including IL-1, IL-6, and TNF- α . These cytokines function to activate the bone marrow by increasing leukocyte production, especially neutrophils.¹⁵ In addition, increased levels of granulocyte-macrophage colony-stimulating factor (GM-CSF) and granulocyte colony-stimulating factor (G-CSF) also play a role in increasing neutrophil production and accelerating their maturation. This results in a significant increase in the number of leukocytes in the peripheral blood.¹⁹ However, excessive increases in leukocytes can harm the healing process of infection. Increased blood viscosity is a primary side effect of severe leukocytosis, which can lead to tissue perfusion disorders.¹

In hyperviscosity conditions, blood flow becomes slower, which can disrupt tissue oxygenation. This risk

can lead to tissue hypoxia, which may ultimately slow the inflammatory healing process and exacerbate the clinical condition of children experiencing infections, such as bronchitis.¹

Aside from physiological disorders that can slow down the healing of infections, leukocytosis that occurs in children under one year old is often associated with systemic symptoms, such as high fever, weakness, and loss of appetite.¹⁵ Proinflammatory cytokines released during the inflammation process, such as IL-6 and TNF- α , can trigger fever responses in the hypothalamus and cause metabolic changes leading to increased muscle protein breakdown to produce energy.¹ This can lead to decreased muscle mass and malnutrition, which can ultimately slow the healing process and increase the risk of further complications, thereby also affecting the length of hospital care.¹⁷

CONCLUSION

Younger age and leukocytosis were significant predictors of prolonged hospitalization in toddlers with bronchitis treated at Bethesda Hospital, Yogyakarta. This study was limited by its cross-sectional design and single-center setting, which restricted causal inference and generalizability. Future research should adopt multicenter, longitudinal designs to confirm the predictor and explore the causal pathways. Clinicians should prioritize early risk factor detection, particularly in children <12 months and those with leukocytosis, to optimize care and reduce hospital stay.

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Conflict of Interest

The authors declared there is no conflict of interest.

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Authors' Contributions

Conceptualized the study, designed the methodology, collected and analyzed the data, and drafted the manuscript: NP. Supervised the study, provided critical revisions of the manuscript for important intellectual content, and approved the final version for publication: OGP, DCAN, YM. All authors contributed and approved the final version of the manuscript.

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