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Assessment of Bronchiolitis Severity Using Modified Tal and BROSJOD Scores

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ABSTRACT

Objective: Although the majority of patients diagnosed with acute bronchiolitis experience a mild and self-limiting clinical progression, others may develop more severe symptoms necessitating oxygen therapy and even hospitalization. This study aimed to evaluate the correlation between the Modified Tal (M-Tal) scores and the Bronchiolitis Score of Sant Joan de Deu (BROSJOD) with the disease's severity, the requirement for oxygen during treatment, and the duration of hospitalization.

Materials and Methods: Infants aged between 1 and 24 months who visited the Pediatrics Clinic and received a first-time diagnosis of bronchiolitis were included in the study. M-Tal and BROSJOD scores were determined according to the patients' findings, and the scores and treatment characteristics were compared.

Results: Average age of 111 patients who fit criteria of the study was 10.4±6.4 (1.5–24.0) months and 70 (63.1%) were male. The mean M-Tal score of the patients was 4.68±2.17 (1–10) and the mean BROSJOD score was 6.91±2.68 (2–15). High-flow nasal oxygen therapy (HFNC) was applied to 22 patients who did not respond to conventional oxygen therapy. The median M-Tal score of patients who underwent HFNC was 7.5, while the median of the BROSJOD score was 10 in those who underwent HFNC and 6 in those who did not (p=0.001). A positive correlation was found between length of hospital stay and M-Tal score and BROSJOD Score (r=0.532, p<0.001: r=0.477, p<0.001, respectively).

Conclusion: Several scoring systems exist to assess the severity of bronchiolitis and determine the need for hospitalization. While these scores are generally useful in studies, none have been consistently proven to be superior in all aspects. Our study's findings align with other bronchiolitis severity scores reported in the literature. However, a different study demonstrated a significant relationship between blood gas parameters and the Modified Wood's Clinical Asthma Score (M-WCAS), a relationship that we did not observe in our study. This discrepancy may be attributed to the early presentation of patients, where elevated scores were detected before changes in blood gas parameters became evident. In conclusion, clinical scoring systems may serve as valuable tools for assessing the severity of bronchiolitis in young children and predicting the potential need for intensive care.

Keywords: Bronchiolitis, High-flow nasal oxygen therapy, Infant, Score

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INTRODUCTION

Bronchiolitis is a respiratory infection resulting from inflammation and blockage in the lower part of the respiratory system. Its etiology is usually seasonal due to factors such as respiratory syntcytial virus, rhinovirus, adenovirus, metapneumovirus, coronaviruses, boca virus, and influenza virus. While most patients with acute bronchiolitis experience a mild, self-limiting clinical course, some may develop more severe respiratory distress and even respiratory failure.[1-3]

Evaluation of severity of disease in patients with bronchiolitis presents some difficulties, and there is no specific laboratory method that is indicative of the severity of the disease. Although pulmonary function tests are useful for assessing the severity of airway obstruction, they are not practical for use in infants. As a result, validated respiratory severity scores, which incorporate factors such as respiratory rate, auscultation findings, use of accessory respiratory muscles during breathing, physical signs like cyanosis, and occasionally oxygen saturation, can provide a more effective means of assessing the severity of bronchiolitis.[4-10] However, since the normal ranges for respiratory rate and heart rate differ across age groups in children, it is important that these scoring systems are arranged accordingly for each age groups. Among these, the Modified Tal (M-Tal) and Sant Joan de Deu (BROSJOD) score classified the number of respiratory rate according to the normal values of different age groups and determined the scores. [6-9] In addition to the M-Tal score, the BROSJOD score added heart rate and lung ventilation to the score parameters and determined the score by separating the number of respiratory rate and heart rate according to age groups.[9]

In this study, our goal is to assess the severity of the disease, treatment course, and hospital stay by applying both scoring systems to the same patient. In addition, we aim to compare the scores with each other.

MATERIALS AND METHODS

This observational prospective study was conducted in the Pediatric Clinic of our hospital with patients aged between 1 and 24 months who were diagnosed with bronchiolitis. The diagnosis of bronchiolitis was made based on clinical findings when cough, wheezing, rales, and tachypnea were accompanied by respiratory distress and use of accessory respiratory muscles following upper respiratory tract infection.[1,2] Information about the age, gender, complaints, clinical findings of these patients (cyanosis, respiratory rate, heart rate, partial oxygen saturation, use of accessory respiratory muscles while breathing and it's degree, and auscultation findings) and laboratory findings at the time of admission to the hospital were recorded and according to the findings, M-Tal and BROSJOD scores were determined (Appendix 1 and 2). Those who have had a bronchiolitis attack before, those who have received nebulization treatment, patients who are younger than 1 month and older than 24 months, those who have chronic heart, chronic lung and neuromuscular diseases, those who have dysmorphia and congenital anomalies (cleft lip and palate, microcephaly, etc.), those who are intubated in neonatal intensive care and infants with bronchopulmonary dysplasia, infants from multiple pregnancies, and infants with birth weight <2500 g (prematurity and infant small for gestational age) were not included in the study. This study was performed in accordance with the principles of the Declaration of Helsinki. Approval was obtained from the ethics committee of the hospital for this study (22/03/2021; number: 45). Patients requiring high-flow nasal oxygenation (HFNC) treatment and length of stay were recorded. The patients' scores, blood gas parameters, HFNC requirement, and length of stay were compared, and a relationship was sought between the scores. Informed consent was obtained from the parents of the participating children. The study procedures were explained in detail, and written consent was obtained.

Statistical Analysis

After the data obtained from the research were coded, it was transferred to the computer and analyzed in the Statistical Package for the Social Sciences (SPSS) (Version 22 for Windows, SPSS Inc., Chicago, IL, USA) package program. Shapiro–Wilk test was used to analyze the suitability of the data for normal distribution. While continuous variables were expressed as mean±standard deviation and median (minimum value–maximum value), frequency data were expressed as numbers and percentage (%). Categorical data were compared using the Pearson Chi-square test and Fisher Exact test. Since continuous variables did not follow a normal distribution, non-parametric tests were used to compare data between groups and in correlational analyses. Mann–Whitney U-test was used to compare paired groups. Kendall's W test for agreement between scores; Spearman correlation test was used for the relationship between scores and other parameters. In all tests, the statistical significance level was accepted as $p<0.05$.

RESULTS

Initially, 132 patients were enrolled in the study, but 21 were excluded due to incomplete records and missing blood gas data, leaving 111 patients for the final analysis. Average age of the patients was 10.4±6.4 (1.5–24.0) months and 63.1% were male (Table 1).

Polymerase chain reaction (PCR) was requested for a total of 72 patients, primarily due to the COVID-19 pandemic, and other etiologies were sought for those who were found negative. COVID-19 PCR was positive in 36 patients. In the respiratory

Table 1. Demographic and laboratory characteristics of the patients

	Mean±SD	Min–Max
Age (month)	10.4±6.4	1.5–24
Weight (kg)	7.2±3.2	3.5–13.5
M-Tal score (median)	4.68±2.17 (4)	1–10
BROSJOD score (median)	6.91±2.68 (6)	2–15
Hemoglobin (g/dL)	11.3±1.86	9,5–13,5
WBC (/mm^3)	12096±4771	4880–13270
Thrombocytes count (/mm^3)	354531±145306	180.000–590000
ph (on admission)	7.36±0.04	7.25–7.45
pCO_2 (on admission)	40.1±5.43	34.3–58.5
	n	**%**
Gender		
Girl	41	36.9
Boy	70	63.1
Age (month)		
1.5–6	38	34.3
7–12	34	30.6
13–24	39	35.1
HFNC/PICU	26	19.8
Total	111	100.0

Percent (%): The percentage of the column. HFNC: High-flow nasal cannula; PICU: Pediatric intensive care unit; BROSJOD: Bronchiolitis Score of Sant Joan de Deu; M-Tal: Modified Tal; WBC: White blood cells; pCO_2: Partial pressure of carbon dioxide; SD: Standard deviation

tract viral panel analysis of the remaining patients, RSV was detected in 10, influenza in 8, rhinovirus in 7 and adenovirus in 2, and no pathogen was found in 11 patients.

M-Tal and BROSJOD scores were determined according to the patients' admission findings.

According to the M-Tal score distribution on admission, 35.1% of the patients were mild, 57.7% have a moderate, and 7.2% have a severe clinical course. The distribution of the scores that patients received from the subcomponents of the M-Tal scoring is shown in Table 2.

According to the BROSJOD score distribution at the time of admission, 39.6% of the patients presented with mild clinical features, 49.6% with moderate features, and 10.8% with severe clinical features. The distribution of the scores that patients received from the subcomponents of the BROSJOD scoring is shown in Table 3.

Table 2. Distribution of M-Tal score parameters in patients

	0 Point n (%)	1 Point n (%)	2 Points n (%)	3 Points n (%)
Respiratory rate	2 (1.8)	66 (59.5)	41 (36.9)	2 (1.8)
Wheezes	13 (11.7)	73 (65.8)	11 (9.9)	13 (11.7)
Oxygen saturation	83 (74.8)	20 (18.0)	7 (6.3)	1 (0.9)
Accessory respiratory muscles	5 (4.5)	33 (29.7)	63 (56.8)	10 (9.0)

%: Percentage of rows. M-Tal: Modified Tal.

Table 3. Distribution of BROSJOD score parameters in patients

	0 Point	1 Point	2 Points	3 Points
Wheezes and rales	13 (11.7)	77 (69.4)	21 (18.9)	
Accessory respiratory muscles	5 (4.5)	82 (73.9)	14 (12.6)	10 (9.0)
Lung ventilation	1 (0.9)	88 (79.3)	18 (16.2)	4 (3.6)
Oxygen saturation	83 (74.8)	26 (23.4)	2 (1.8)	
Respiratory rate	2 (1.8)	64 (57,7)	40 (36.0)	5 (4.5)
Heart rate	3 (2.7)	40 (36.0)	54 (48.6)	14 (12.6)

%: Percentage of rows. BROSJOD: Bronchiolitis Score of Sant Joan de Deu.

When comparing BROSJOD and M-Tal scores, 32 patients were classified as mild, 48 as moderate, and 8 as severe according to the both scoring systems (Table 4).

According to the analysis performed to evaluate the consistency between scores, agreement was found between BROSJOD and M-Tal scores (Kendall's W=0.854, p<0.001). According to another analysis performed for the agreement between the scores, a moderate agreement between the scores was found (Kappa=0.603).

Table 4. Classification of M-Tal and BROSJOD scores in patients

BROSJOD score	M-Tal Score			Total
	Mild	Moderate	Severe	
Mild	32	12	0	44
Moderate	7	48	0	55
Severe	0	4	8	12
Total	39	64	8	111

BROSJOD: Bronchiolitis Score of Sant Joan de Deu, M-Tal: Modified Tal.

Patients showing signs of respiratory failure were initiated on HFNC therapy, and those who didn't respond were transferred to the pediatric intensive care unit (PICU). Throughout the follow-up of the patients involved in the study, it was found that 80.2% did not need HFNC or PICU, while 17.1% needed HFNC and 2.7% also needed pediatric intensive care. These patients were evaluated and compared based on their M-Tal and BROSJOD scores. It was observed that the average M-Tal and BROSJOD scores of those who needed HFNC/PICU were higher than those who did not need HFNC/PICU (p=0.001; p=0.001, respectively) (Figs. 1 and 2). However, no statistically significant difference in pH and partial pressure of carbon dioxide (pCO2) values on admission (p>0.05) (Table 5).

An analysis of the relationship between M-Tal score, BROSJOD scores, and pH and pCO_2 levels on admission revealed no statistically significant correlation between the M-Tal score and pH and pCO_2 levels on admission (r=−0.064, p=0.508; r=−0.018, p=0.855, respectively). No statistically significant correlation between BROSJOD score and pH and pCO_2 on admission (r=−0.039, p=0.685; r=−0.009 p=0.922, respectively).

Average hospital stay of the patients was 4.2±3.3 days. A positive and moderate correlation was found between the duration of hospitalization and M-Tal and BROSJOD scores (r=0.532, p<0.001; r=0.477, p<0.001, respectively) (Table 6).

DISCUSSION

Hospitalization is reported in approximately 13.3–16% of children with bronchiolitis under the age of 2 years.[11,12] About 2–13% of these patients also require treatment in the PICU.[11,13,14] Our patients consisted of hospitalized patients and HFNC treatment was applied to approximately one-fifth.

Several scoring systems, such as the modified Woods Asthma score, M-Tal, BROSJOD scores, are available to assess disease severity and determine the need for hospitalization in patients with bronchiolitis. Although the scores are generally useful in studies, no score has been shown to be superior to others in every aspect.[13,14] The Tal score was first defined in 1983, and in the following years, McCallum et al.[6] adjusted the respiratory rate according to age and modified it by changing oxygen saturation instead of cyanosis which is one of its components, and was validated by Golan-Tripto et al.[7], [5,8] It has been suggested that the M-Tal score is a more accurate predictor of disease severity compared to the Tal score. Different studies have reported that, M-Tal score is a simple and dependable method for hospital admissions. It has been demonstrated that the M-Tal score is a reliable and easily applicable criterion, especially when compared to other scoring systems, for deciding hospitalization in bronchiolitis patients.[15] Our patient group consisted of inpatients and the M-Tal score was generally moderate.

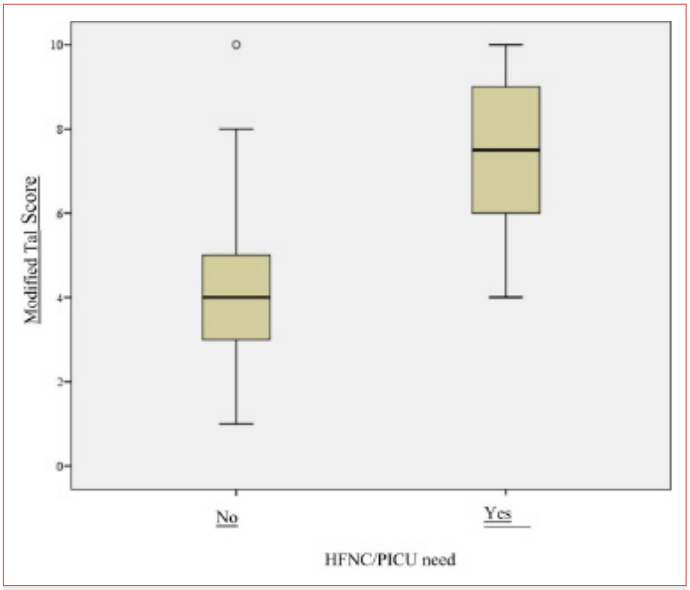

Figure 1. Modified Tal score comparison according to HFNC/PICU need.

HFNC: High-flow nasal cannula; PICU: Pediatric intensive care unit.

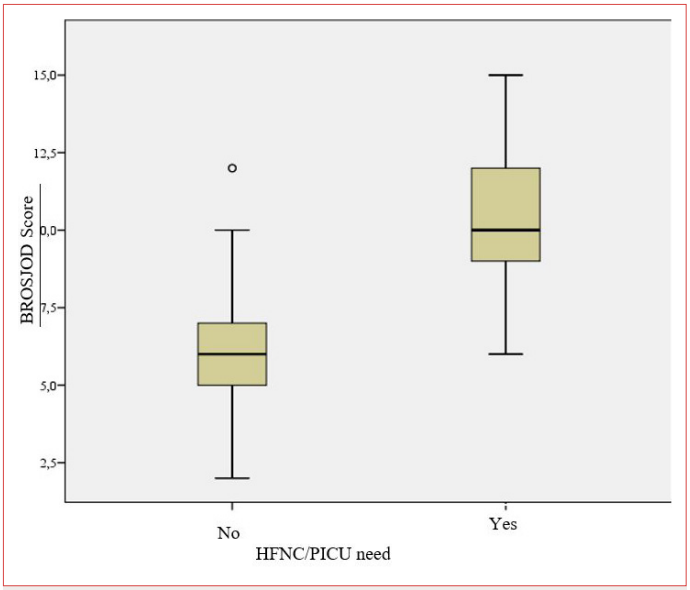

Figure 2. BROSJOD score comparison according to HFNC/PICU need.

BROSJOD: Bronchiolitis score of Sant Joan de Deu; HFNC: High-flow nasal cannula; PICU: Pediatric intensive care unit.

The BROSJOD score evaluates heart rate as well as respiratory findings. Unlike other scores, it also evaluates heart rate and provides the opportunity to score according to age groups. Balaguer et al.[9] evaluated the relationship between

Table 5. Comparison of M-Tal and BROSJOD according to HFNC/PICU need

	No of patient	Median	Min.	Max.	P*
M-Tal score according to HFNC/PICU need					
No need	89	4,0	1	10	**<0.001**
Needed	22	7,5	4	10	
BROSJOD score according to HFNC/PICU need					
No need	89	6	2	12	**<0.001**
Needed	22	10	6	15	
Ph according to HFNC/PICU need					
No need	89	7.37	7.24	7.46	0.781
Needed	22	7.37	7.19	7.43	
CO_2 according to HFNC/PICU need					
No need	89	40.6	24.4	51.4	0.953
Needed	22	41.0	25.0	54.3	

Mann–Whitney U. HFNC: High-flow nasal cannula; PICU: Pediatric intensive care unit; BROSJOD: Bronchiolitis Score of Sant Joan de Deu; M-Tal: Modified Tal; CO_2: Carbon dioxide.

Table 6. Relationship between length of stay and M-Tal and BROSJOD Score

	M-Tal score	BROSJOD score
Length of Hospitalization (day)		
n	111	111
r	0.532	0.477
P*	<0.001	<0.001

Spearman correlation test. BROSJOD: Bronchiolitis Score of Sant Joan de Deu; M-Tal: Modified Tal.

bronchiolitis severity and BROSJOD and reported that as the scale score increased, the patient's oxygen and ventilation requirements increased.[9] In a study, it was suggested that the best-validated score among bronchiolitis scores is BROSJOD, and that the sensitivity of the BROSJOD score is higher than others, especially in RSV infections, and that it is followed by the M-Tal score.[16] In our study, a significant number of the patients were found to have COVID-19 as the underlying cause. It was observed that M-Tal and BROSJOD scores were high in line with the severity of bronchiolitis, patients with high scores needed HFNC treatment, and some of them required treatment in the PICU.

Guitart et al.[17] compared M-Tal and BROSJOD scores and reported that they were not superior to each other. In different studies, it has been reported that the M-Tal score is compatible with the Wang score, and in another study, it is also compatible with the BROSJOD, ESBA, and Wood-Downes-Ferrés scores.[10,17] Similarly, in our study, no superiority was shown between the M-Tal and BROSJOD scores, and there was no superiority between them. A medium strength relationship was detected.

It is recommended that respiratory failure that may occur in patients be monitored with blood gas parameters (p<7.25; PCO_2>45 mmHg).[18] The association between blood gas levels and respiratory scores has been demonstrated in bronchiolitis patients treated in the PICU, using another respiratory scoring system, the Modified Wood's clinical asthma score.[19,20] In our study, patients were evaluated according to their blood gas parameters at admission. However, no relationship was found between the scores and pH and PCO_2 levels. It is thought that this result is due to the fact that the patients applied early and the scores were found to be high without being reflected in the blood gases. In our study, only blood gases at the time of admission were evaluated; it is thought that this result occurred because their levels during follow-up were not evaluated.

Proven treatment options for bronchiolitis are hydration, oxygen, and nasal aspiration.[1,2] In situations where conventional oxygen therapy is ineffective, HFNC treatment is recommended. If HFNC treatment fails to provide adequate support, invasive ventilation is advised.[21-23] Studies have reported that HFNC treatment may be a safe treatment option that helps improve clinical parameters such as oxygen saturation, heart rate, respiratory rate, and blood gas levels in patients with

bronchiolitis. This treatment approach may help decrease the need for invasive ventilation support.[23,24] In their study on infants with bronchiolitis aged 1–24 months Murphy et al.[25] found that HFNC use led to improvements in respiratory parameters, heart rate and M-Tal scores compared to the control group. However, there was no significant difference in hospitalization duration with this treatment. In another study, it was suggested that an M-Tal score of >5 4 h after HFNC treatment and a young age indicate HFNC insufficiency.[26] In cases where the BROSJOD score is >8, HFNC treatment is recommended.[27] The scores of our patients were found to be higher in those requiring HFNC and PICU than the others and showed similar scores. This shows that these scores have a significant place in determining the severity of bronchiolitis.

The hospitalization length in patients with bronchiolitis is generally reported to be 3–7 days.[3,10] Another result of our study was that the hospitalization length of patients with high scores was longer than the others. In different scores made in patients with bronchiolitis, neither the Children's Hospital of Wisconsin Respiratory Score nor Respiratory Distress Assessment Instrument showed a significant relationship with the duration of hospitalization and the scores.[28-30] The pediatric component of the comprehensive severity index scoring, which evaluates clinical, laboratory and radiological findings, was found to be associated with the duration of hospital stay.[31] Our research is the first to investigate the relationship between length of hospital stay and M-Tal and BROSCOD scores. The fact that this result is achieved by only including clinical findings and oxygen saturation in our scoring systems shows that these scores also have an effect on prognosis. However, it has been reported that there is no effect in the duration of hospital stay of patients with high M-Tal and severe respiratory distress who require HFNC treatment compared to those who are not given HFNC treatment.[25] Unlike treatment methods, patients with high scores are thought to require longer hospitalization.

CONCLUSION

As the BROSJOD and M-Tal scores increase, the length of hospitalization also increases. This indicates that clinical scoring systems may be valuable tools for assessing the severity of bronchiolitis in young children and predicting the potential need for intensive care.

Limitations

The first limitation is that our patient group was small-scale, the second is that not all respiratory viruses were isolated, another is that the study was conducted during the pandemic, and the last limitation is that it was a single-center study.

This study was based on the my medical specialization thesis of the corresponding author.

DECLARATIONS

Ethics Committee Approval: The study was approved by University of Health Sciences, Hamidiye Medical Faculty Ethics Committee (No: 45, Date: 22/03/2021).

Author Contributions: Concept – L.A., Y.T.; Design – L.A., Y.T.; Supervision – Y.T.; Fundings – L.A., A.K., M.T.P. Y.T.; Materials – L.A., A.K., M.T.P. Y.T.; Data collection &/or processing – L.A.; Analysis and/or interpretation – L.A., Y.T.; Literature search – L.A., A.K., M.T.P. Y.T.; Writing – L.A., Y.T.; Critical review – L.A., A.K., M.T.P. Y.T.

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Appendix 1. Modified Tal score (6.8)

SCORE	Respiratory rate/min		Wheezes	Oxygen saturation	Accessory respiratory muscles
	<6 months	>6 months			
0	<40	<30	No	≥95	No
1	41–55	31–45	With Stethoscope During Expiration	92–94	+
2	56–70	46–60	During Inspiration and Expiration	90–91	++
3	>70	>60	Without Stethoscope	≤89	++++

The total score obtained from the M-Tal score is considered as mild disease between 1 and 3 points, as moderate disease between 4 and 8 points, and as severe disease between 9 and 12 points.

Appendix 2. BROSJOD Score (9)

Wheezes and Rales	0: No			
	1: Expiratory wheezes, inspiratory rales			
	2: Expiratory and inspiratory wheezes/rales			
Accessory respiratory muscles	0: No			
	1: Subcostal, lower intercostal			
	2: (1) + supraclavicular + nasal flaring			
	3: (2)+ upper intercostal + tracheal retraction			
Lung ventilation	0: Normal			
	1: Regular and symmetrical			
	2: Asymmetrical			
	3: Very little			
Oxygen saturation	Without oxygen	With oxygen		
	0: >95%	1:>94% with FiO_2 ≤40%		
	1: 91–94%	2:<94% with FiO_2 >40%		
	2: <94%			
Respiratory rate (beats/min)	0	1	2	3
<3 months	<40	40–60	60–70	>70
3–12 months	<30	30–50	50–60	>60
12–24 months	<30	30–40	40–50	>50
Heart rate (beats/min)	0	1	2	3
<1 year	<130	130–150	150–170	>170
1–2 years	<110	110–120	120–140	>140

O_2: Oxygen; FiO_2: Fraction of inspired oxygen, BROSJOD: Bronchiolitis Score of Sant Joan de Deu. When the total score from the BROSJOD Bronchiolitis Score is evaluated, 0–5 points are considered minor crisis; 6–10 points, moderate crisis; and 11–16 is considered a severe crisis.