

Bronchiolitis Severity Based on Modified Tal Score and Chest X-ray Findings; Is There any Association?

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ABSTRACT

Background: This study was performed to determine the relationship between chest X-ray findings and the severity of bronchiolitis using the modified Tal score scale (MTS).

Methods: This retrospective study was conducted among 999 children aged 2-24 months admitted to a referral teaching hospital in Isfahan, Iran. The severity of bronchiolitis was determined by MTS criteria, with scores ranging from 0 to 12. We considered scores 0-5 mild, 6-9 moderate, and 10-12 severe bronchiolitis. The patient's CXRs were also extracted from the hospital's picture archiving and communication system (PACS) and reported by an expert Pediatric radiologist. The radiologic findings were compared with the MTS criteria.

Results: The mean (SD) of the MTS score in the patients was 4.58 ± 1.92 . Overall, 757 patients (75.78%) had normal radiographies. The frequency of normal radiography was 75.3% in the group of mild bronchiolitis and 77.3% in the group of moderate bronchiolitis. Reports of 9 patients with severe disease showed that 6 of them had normal CXRs (66.7%), 2 had hyperinflation, and 1 had atelectasis. There was no statistically significant relationship between radiographic results and the severity of bronchiolitis, according to MTS criteria ($P = 0.23$). The agreement between radiographic results and the severity of bronchiolitis was very weak (0.004) without statistical significance ($P = 0.632$).

Conclusion: Considering that 99.3% of children with bronchiolitis do not have significant findings in chest X-rays, routine chest X-ray is not recommended in these patients.

Keywords: Bronchiolitis, Early warning score, Mass chest X-ray

Introduction

Acute bronchiolitis is a viral infection of the lower respiratory tract in children and is one of the most common reasons for hospitalization in children aged 2 to 24 months (1). Respiratory Syncytial Virus (RSV) is the most common pathogen responsible for Acute bronchiolitis (1, 2).

According to American Academy of Pediatrics guidelines, the diagnosis of bronchiolitis is clinical, based on history and physical examination, signs, and symptoms (2). Symptoms include cough and coryza, shortness of breath, tachypnea, nasal

flaring, chest retractions, wheezing, and/or crackles, followed by a viral upper respiratory infection (3, 4).

Studies have shown that treating bronchiolitis in mild to moderate cases is supportive (5). However, different approaches may be used in the clinic, such as lab tests and antibiotics (6). Many physicians also widely use imaging studies, such as taking a chest x-ray (CXR) (7, 8). These imagings are mostly unspecific or even normal, so a chest X-ray is not a necessary or valid tool for diagnosing

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Please cite this paper as:

Amini N, Riahinezhad M, Faraji S, Keivanfar M. Bronchiolitis Severity Based on Modified Tal Score and Chest X-ray Findings; Is There any Association? Iranian Journal of Neonatology. 2024 Jul; 15(3). DOI: [10.22038/IJN.2024.75677.2457](https://doi.org/10.22038/IJN.2024.75677.2457)



Table 1. modified Tal score

Modified Tal score					
Respiratory rate (breaths/min)					
Accessory respiratory	Saturation O ₂ (Room air)	Wheezing/Crackles	Age ≥6 months	Age <6 months	Score
None (no chest in-drawing)	95≥	None	30≤	40≤	0
+ presence of mild intercostal in-drawing	92-94	Expiration only	31-45	41-55	1
++ Moderate amount of intercostal in-drawing	90-91	Expiration and inspiration with stethoscope only	46-60	56-70	2
+++ Moderate or marked intercostal in-drawing, with present of head bobbing or tracheal tug	89≤	Expiration and inspiration without stethoscope only	61≥	71≥	3

acute bronchiolitis (6) and not affect the patient's final results and prognosis. They can also cause more antibiotic use and increase hospitalization time (7).

In 2014, The American Academy of Pediatrics declared diagnostic imaging for bronchiolitis unnecessary (8, 9).

Bronchiolitis severity scores are criteria for quickly determining the severity of the disease based on the patient's signs and symptoms. Different types of these scores have been introduced, but their use in the clinic is limited (10, 11).

Using these scoring systems may reduce unnecessary chest X-rays (6).

One of these scoring systems is the Modified Tal Score (MTS), which has proven valid (12, 13).

Scoring in this system is based on four criteria: 1. respiratory rate, 2. abnormal respiratory sounds such as wheezing or crackles, 3. oxygen saturation in room air, and 4. accessory respiratory muscle utilization. (12, 14) (Table 1)

In most cases, the CXR is normal in bronchiolitis, and there is no need for a routine CXR. However, the question is whether taking a CXR for severe bronchiolitis is unnecessary. Moreover, can the severity of bronchiolitis be related to radiographic findings? Can a criterion be found to select the patients with bronchiolitis who need a CXR? The present study was designed to find the answers to these questions. The goal is to avoid requesting unnecessary chest X-rays, reducing treatment costs, using unnecessary antibiotics, and receiving harmful radiation. (12, 13, 15)

Methods

This retrospective study, approved by the Medical Ethics Committee of Isfahan University of Medical Sciences, was conducted in 2020 at Imam Hossein Children's Hospital in Isfahan, Iran.

The study's target population was children hospitalized between 2-24 months with

bronchiolitis over four years between September 2015 and September 2019.

Inclusion criteria

All patients aged one month to two years with a recorded diagnosis of bronchiolitis; sufficient information in the patient's file, including age, sex, and treatments performed; information for calculating the modified Tal score (MTS) includes the percentage of blood oxygen saturation, retraction, number of breaths per minute, and the presence or absence of wheezing or crackling in the lungs, and the Presence of radiographic images.

Exclusion criteria

The study excluded cases where the patient's record had a major defect, including demographic findings (such as age and sex), Treatments performed, blood oxygen saturation, presence or absence of retraction, respiratory rate per minute, and the presence or absence of wheezing or crackling in the lungs (items needed to calculate the score). Moreover, it was impossible to eliminate these defects by contacting the patient's family and patients for whom another diagnosis was made during hospitalization.

This study was performed using the census method. Patients were identified using the electronic database of Imam Hossein Children's Hospital admissions. We included all patients hospitalized in this hospital due to bronchiolitis and had the inclusion criteria. At first, the list of eligible patients was prepared, and then the required information was extracted and recorded in the data collection form by reviewing the patients' files. Chest X-rays were identified using the PACS and were reported by an expert pediatric radiologist. Findings were recorded in the patient's checklist. Patients' X-rays can be normal or have abnormal findings such as atelectasis, consolidation, hyperinflation, and bronchial thickening. The severity of bronchiolitis

in patients was initially determined using the Modified Tall Score.

Scoring in this system is based on the following four criteria: the number of breaths per minute; patients in two age groups were evaluated: under six months and six months and above; abnormal sounds in the lungs during the examination, including wheezing and crackling; the percentage of blood oxygen saturation measured by pulse oximeter in room air; and Respiratory effort and use of accessory respiratory muscles.

Each of the above criteria is assigned a score of 0 to 3, and the sum of the scores can be from 0 to 12. (Table 1) Based on the total scores, 0-5 was considered mild bronchiolitis, 6-9 moderate bronchiolitis, and 10-12 severe bronchiolitis. (12, 14) After collecting the study data, it was entered into SPSS software version 26 and analyzed with statistical tests such as the Chi-squared and T-test.

Ethical approval

This study is the result of research project No. 399165 and ethical code IR.MUI.MED.REC.1399.293, which was approved by the Isfahan University of Medical Science.

Results

This study studied 999 children hospitalized in the 2-24 months age group with bronchiolitis over

four years between September 2015 and September 2019. The mean age of the patients was 5.75 ± 4.35 months; 572 (57.3%) were in the age group of less than six months, and 427 (42.7%) were in the age group of 6 months and above. Of the 999 patients, 616 (61.7%) were boys, and 383 (38.3%) were girls. The mean age of the boys and girls was 5.77 ± 4.33 and 5.73 ± 7.39 months, respectively, and there was no significant difference between the two sexes ($P = 0.89$).

The mean MTS in the studied patients was 4.58 ± 1.92 , ranging from 0 to 11. According to it, 699 patients (70%) had mild bronchiolitis, 291 (29.12%) had moderate bronchiolitis, and 9 (0.9%) had severe bronchiolitis.

The study of MTS criteria shows that 93.2% of the patients had abnormal (rapid) breathing, and 64% had different degrees of wheezing and crackling. Also, 75.2% of patients had less than 95% oxygen saturation, and more than half (52.3%) had varying degrees of respiratory effort and use of accessory respiratory muscles. Table 2 shows the frequency distribution of bronchiolitis symptoms according to MTS criteria.

The mean MTS in patients under six months was 4.45 ± 1.92 and 4.76 ± 1.92 in 6 months and older, and the severity of bronchiolitis in children six months and older was significantly higher ($P=0.013$).

Table 2. distribution of bronchiolitis symptoms according to MTS criteria

Criterion	age is in months	Number of patients mean(percent)	percentage
Respiratory rate per minute	All patients		6.8
	6<: 40 and less	68(6.8)	(4.4-8.6)
	: 30 and less \geq 6		24.7
	All patients (31-45:6 \geq - 41-55:6<)	247(24.7)	(14.5-32.3)
Respiratory rate per minute	All patients (46-60:6 \geq - 56-70:6<)	643(64.3)	64.3 (81-51.9)
	All patients 6<: more than 70	41(4.1)	4.1 (81-51.9)
	: more than 60 \geq 6		
Wheezing/ Crackles	Non	360(36)	36
	Expiration only	477(47.7)	47.7
	Expiration and inspiration with stethoscope only	65(6.5)	6.5
	Expiration and inspiration without stethoscope	97(9.7)	9.7
Oxygen saturation percentage	95 and more	248(24.8)	24.8
	92-94	372(37.2)	37.2
	90-91	149(14.9)	14.9
	Less than 90	230(23)	23
Accessory respiratory muscle utilization	Non(no chest in- drawing)	477(47.7)	47.7
	Presence of mild intercostal in- drawing	482(48.2)	48.2
	Moderate amount of intercostal in- drawing	39(3.9)	3.9
	Moderate or marked intercostal in- drawing with present of head bobbing or tracheal tug	1	0.1

Table 3. Frequency distribution of bronchiolitis severity by age and sex

radiographic findings	bronchiolitis severity based on MTS			P-value
	Mild(mean+percent)	moderate(mean+percent)	severe(mean+percent)	
Less than 6 months	3(33.3)	160(55)	3(33.3)	0.31
6 months and more	6(66.7)	131(45)	6(66.7)	
boy	5(55.6)	172(59.1)	5(55.6)	0.21
girl	4(44.4)	119(40.9)	4(44.4)	

Table 4. Frequency distribution of radiographic findings on the severity of bronchiolitis (MTS)

radiographic findings	bronchiolitis severity based on MTS			P-value
	Mild(mean+percent)	moderate(mean+percent)	Severe(mean+percent)	
Normal	526(75.3)	225(77.3)	6(66.7)	0.64
Abnormal	173(24.7)	66(22.7)	3(33.3)	
Agreement		0.004		0.632

The mean scores in boys and girls were. 4.50 ± 1.95 and 4.71 ± 1.87 , respectively, and no significant difference was observed between the two sexes ($P =$ Reports of the patient's chest radiographs showed that 757 patients (75.78%) had normal and 242 (24.22%) had abnormal CXR. The main radiographic abnormal finding was hyperinflation, so out of 242 abnormal radiographs, only pulmonary hyperinflation was reported in 237 cases (97.5%). In fact, no significant radiological findings were seen in 993 patients, or 99.3%. Other reported cases included 6 cases (2.5%) of atelectasis.

The mean score of the MTS in patients with normal and abnormal CXRs was 4.60 ± 1.90 and 4.51 ± 1.998 , respectively, and was not significantly different ($P = 0.53$).

Table 4 shows the frequency distribution of

radiographic findings on bronchiolitis (MTS) severity. According to the results, out of 699 children with mild bronchiolitis, 526 (75.3%) had normal CXRs. Also, out of 291 children with moderate bronchiolitis, 225 (77.3%) had normal CXRs, and out of 9 patients with severe bronchiolitis, 6 (66.9%) were reported as normal.

According to Fisher's exact test, no statistically significant relationship was observed between radiographic findings and the severity of bronchiolitis (based on MTS)($P = 0.64$). Also, according to the Kappa test, a very weak agreement of 0.004 was observed between radiographic findings and the severity of bronchiolitis, which was not statistically significant ($P = 0.632$).

As can be seen in Table 5, the frequency of normal and abnormal CXRs in each item is very

Table 5. Frequency distribution of MTS criteria in two groups with normal and abnormal CXRs

Criterion		All patients (mean+percent)	Radiographic findings		P-value
			Normal (mean+percent)	Abnormal (mean+percent)	
Respiratory rate per minute	0	68(6.8)	47(6.2)	21(8.6)	0.55
	1	247(24.7)	186(24.6)	61(21.5)	
	2	643(64.3)	453(65.2)	150(61.7)	
	3	41(4.1)	30(4)	11(4.5)	
Wheezing/ Crackles	Non	360(36)	272(36)	88(36.2)	0.57
	Expiration only	477(47.7)	367(48.5)	110(45.3)	
	Expiration and inspiration with stethoscope only	65(6.5)	45(6)	20(8.2)	
	Expiration and inspiration without stethoscope	97(9.7)	72(9.5)	25(10.3)	
Oxygen saturation percentage	95 and more	248(24.8)	181(23.9)	67(27.6)	0.33
	92-94	372(37.2)	280(37)	92(37.9)	
	90-91	149(14.9)	111(14.7)	38(15.6)	
	Less than 90	230(23)	184(24.3)	46(18.9)	
Accessory respiratory muscle utilization	Non(no chest in- drawing)	477(47.7)	371(41.9)	106(46.3)	0.20
	Presence of mild intercostal in- drawing	482(48.2)	359(47.5)	123(50.6)	
	Moderate amount of intercostal in- drawing	39(3.9)	25(3.3)	14(5.8)	
	Moderate or marked intercostal in- drawing with present of head bobbing or tracheal tug	1	1(0.1)	0	

close to each other, and according to the Chi-square test and Fisher's exact test, the frequency of MTS criteria according to radiographic findings is not significantly different ($P < 0.05$)

Examination of radiographic findings by age and sex of patients also showed that the frequency of abnormal CXRs in terms of age ($P = 0.74$) and sex ($P = 0.44$) did not differ significantly. The frequency of abnormal CXRs was 134 cases (23.4%) in children under six months and 109 cases (25.5%) in children six months and older. Also, abnormal CXRs were 152 (24.7%) in boys and 91 (23.8%) in girls.

The mean length of hospital stay in all patients was 2.99 ± 1.97 days, ranging from 1-17 days. This mean of hospitalization in patients with mild, moderate, and severe bronchiolitis was 2.99 ± 2 , 2.97 ± 1.85 , and 3.78 ± 2.44 days, respectively, and there was no significant difference in length of hospital stay according to the severity of bronchiolitis ($P = 0.48$). The mean length of hospital stay in patients with normal and abnormal CXRs was 2.99 ± 1.97 and 3 ± 1.96 days, respectively, and there was no significant difference between the two groups ($P = 0.898$).

Discussion

Acute bronchiolitis is one of the most common reasons for hospitalization in children 2-24 months of age (1, 2). Unnecessary chest radiographs are taken in over 40% of cases (7, 8), although chest X-ray (CXR) is only indicated in severe cases or cases with risks of pulmonary complications (1, 2).

In addition to increasing hospitalization costs, this is associated with the risks and complications of radiation for children (16).

The most common reason for using these radiographs is to ensure that lower airway bacterial infections are ruled out. However, studies show that radiographic findings are found in a small population of patients with bronchiolitis, including atelectasis, hyperinflation, alveolar thickening, and alveolar infiltration (11).

Due to the high prevalence of bronchiolitis in children and their exposure to unnecessary radiation, this study was performed to determine the relationship between chest X-ray findings and the severity of bronchiolitis in terms of modified Tal score in patients admitted with the diagnosis of bronchiolitis.

In this study, we studied 999 children admitted to the hospital diagnosed with bronchiolitis. According to the MTS criteria, each patient had some degree of bronchiolitis severity. However, in

the reports of chest radiographs of these patients, less than a quarter of them (24.3%) Had an abnormal radiograph. On the other hand, the abnormal findings mainly included pulmonary hyperinflation. Thus, 99.3% of patients had no significant radiological findings. Therefore, radiological findings seem to be neither useful in diagnosis or treatment nor in predicting clinical course.

In this regard, the results of a study by Arnoux et al. Showed that performing unnecessary radiographs changed the patient's course of treatment and led to the administration of antibiotics. In contrast, the patient had typical symptoms of bronchiolitis and did not need to be prescribed antibiotics (17). Also, the results of the Nazif study, which aimed to determine the relationship between radiographic findings and disease symptoms, showed that 84% of patients had a normal radiographic appearance, similar to our study's results (18).

In contrast to the present study's results, the study results by Kamble et al. (13) showed that in both ARI scoring systems (RSS and MOD TAL), the number of patients requiring oxygen and the length of hospital stay also increased significantly with increasing severity, with RSS showing a stronger correlation. This inconsistency can be attributed to the age of the children studied. The present study examined children aged 2 to 24, while their study examined children under 24. However, the number of samples in the present study was much larger than in the authors' study, and the study results can more reliably express the accuracy of the TAL method.

In agreement with the results of the present study, the study by Cavari et al. (19) showed that 30 minutes after treatment, TC CO₂ decreased, and MTS increased concomitantly. However, there was no difference between the groups when evaluating the lung atelectasis score using chest radiographs.

A study by Juan Manuel Rius Peris et al., Which aimed to evaluate radiographic findings in patients with bronchiolitis and to evaluate the agreement between these findings by different observers, showed that radiographic findings in bronchiolitis were nonspecific and dependent on the Experience and skill of the observer; therefore The low levels of agreement between observers and the wide variability, makes the chest X-ray an unreliable diagnostic tool. (20) Also, the results of a study by Zipursky et al. Showed that inappropriate use of antibiotics for children with bronchiolitis was often associated with taking

unnecessary radiographs (21). Biagi et al. Were conducted to find the best tools for diagnosing complicated bronchiolitis and pneumonia. They concluded that in a patient with bronchiolitis, lung ultrasound is a more accurate, cheaper, and safer tool than radiography and is preferable to it (1).

The results of the Friedman study also showed that radiographic findings in children with bronchiolitis are often normal, and a small percentage of these children may have findings such as atelectasis and bronchial infiltration that do not help the treatment process and lead to overuse of antibiotics (22).

Most studies confirm bronchiolitis is a clinical diagnosis based on the patient's history and physical examination (23). Signs and symptoms include runny nose, tachypnea, cough, wheezing, crackling, nasal flaring, and use of the accessory respiratory muscles (24).

Despite the emphasis of various guidelines on the clinical diagnosis of bronchiolitis and the lack of need for chest X-rays, these X-rays are still widely performed, and often their findings are non-diagnostic (7, 25).

Another noteworthy fact is that some previous studies have reported different results for lung radiographic findings in the diagnosis of bronchiolitis (9, 26). However, most clinical guidelines do not recommend the use of radiography in typical cases of bronchiolitis (25). Based on the findings of our study, it can be concluded that chest X-ray is not useful in the diagnosis of bronchiolitis.

The strengths of this study were the large sample size and the reporting of all CXRs by an expert radiologist in pediatric radiology. However, our study also had its limitations. For example, the information needed to calculate MTS and related examinations has been recorded in patients' records by different physicians; therefore, it is suggested that more be done in this regard.

Conclusion

Because a high percentage of children with bronchiolitis have normal radiographic views of the lungs, routine chest radiography is not recommended in these patients. Therefore, a modified Tal score instead of conventional chest radiography is recommended to diagnose bronchiolitis severity in children aged 2 to 24 months more accurately.

Acknowledgments

This study is the result of research project No. 399165 and ethical code IR.MUI.MED.REC.

1399.293, which was approved by the Isfahan University of Medical Science. We appreciate the financial and spiritual support provided.

Conflicts of interest

The authors declare that there is no conflict of interest and that they alone are responsible for the integrity and accuracy of the paper's content.

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