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Original Article

Correlation between Modified Tal Score and Oxygen Saturation Values Detected by Pulse Oximeter in Children with Bronchiolitis

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Abstract

Background: *A number of clinical scoring systems have been used for risk stratification of children with bronchiolitis, most of them have not validate in our setting. Modified Tal's Score (MTS) is one of such clinical score. This study aimed to determine the relation between MTS and oxygen saturation (SpO_2) measured by pulse Oximeterin children with acute bronchiolitis patients admitted to a tertiary-level hospital in Bangladesh. .*

Materials and methods: *This cross-sectional study included 251 children aged <24 months with bronchiolitis from the department of pediatrics of Chittagong Medical College Hospital from April 2021 to March 2022. Severity was assessed by MTS and simultaneously SpO_2 of patients were seen and recorded in a case record form. Correlation between MTS and SpO_2 was assessed.*

Results: *MTS showed a strong negative linear correlation with SpO_2 (r = 0.82, 95% CI: -0.857 to -0.775). Linear regression analysis showed that 58.5% of the variation in SpO_2 can be explained by the model containing only MTS. The mean (± SD) SpO_2 value was 96.3±2.4% in children with a score of 2–5 (n=140), 90.65±5.6% in those with a score of 6–7 (n=48) and 86.6±4.7% in children with a score of 8 or more(n=63), ($p < 0.001$ by Bonferroni's multiple comparison, when all two-way comparisons were done for each pair of results). With the cutoff value of 6, the MTS had 96.61% sensitivity, 71.88% specificity, and 98.57% negative predictive value to detect hypoxaemia.*

Conclusions: *As modified TAL's clinical scoring system strongly correlates with the SpO_2, in absences of pulse oximetry MTS can be used to confirm severity of hypoxaemia in infants with bronchiolitis.*

Key words: Bronchiolitis; Modified Tal's clinical score; pulse oximetry.

INTRODUCTION

Bronchiolitis is the leading cause of hospital admission for respiratory diseases among infants less than one year.[1] Several respiratory scores have been created to assess the level of severity and progression of the disease and the efficacy of therapeutic interventions in brochiolitis.[2] Although pulmonary function testing helps determine the severity of airway obstruction, it is often neither feasible nor easily accessible in infants. For these reasons, validated respiratory severity scores consisting of clinical symptoms and physical signs can help assess the severity of bronchiolitis.[2] Clinical scoring systems are assessment tools that, based on the observation of certain variables in patients with a disease, allow the addition of ratings given to different items to obtain a total, cumulative score. Several scales have been published for assessment of bronchiolitis.[3-6]

Hypoxaemia is one of the severe manifestations of bronchiolitis which requires early

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detection and treatment.[7] Transcutaneous oxygen saturation (SpO_2) is reduced in moderate to severe bronchiolitis cases. Recent management guidelines have suggested lower limits of acceptable SpO_2 levels of 90% for infants with bronchiolitis. The use of pulse oximetry monitoring is recommended routinely in infants with bronchiolitis who require supplemental oxygen or have $SpO_2 \leq 90\%$ on room air.[8,9] Pulse oximetry is a simple, non-invasive method, and it gives a fast and reasonably accurate assessment of SpO_2.[10] There have been encouraging results in previous studies which have tried to establish a correlation between clinical scoring systems and hypoxaemia as measured by pulse oximetry (SpO_2) in children.[2,11-14]

At face value, the scoring system devised by Bierman and his colleague for asthma and modified by Tal et alfor bronchiolitis that included a four clinical parameter [Cyanosis, Respiratory Rate (RR) wheeze and retractions] is the most clinically appropriate and most user-friendly.[6,15] Pavon et allater on modified the TAL's score [Termed as Modified-Tal Score (MTS) in the present study] and the modification was done only in the respiratory frequency according to age (<6 months and ≥6 months).[12] Recently, McCallum et almodified this system to replace cyanosis with SpO_2.[2] Each component scored between 0 and 3, providing a composite score of 0–12.[2]McCallum et al. identified the MTS as the most clinically appropriate and easy to use.[2] However, the applicability of the MTS system has not been tested in Bangladeshi children yet. This study was designed to assess the relationship between SpO_2 and MTS in children with bronchiolitis less than 24 months of age admitted to a tertiary level hospital in Bangladesh.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted in the Department of Paediatric of Chittagong Medical College Hospital, Chattogram from April 2021 – to March 2022. The study protocol was approved by the Ethical review Committee of Chittagong Medical College and for each participating infant, at least one parent gave their signed informed consent before enrollment.

Children with bronchiolitis attending Inpatient and Outpatient Department and age between 1month to 24 months were included in this study. Exclusion criteria were children with clinical pneumonia, radiological pneumonia, congenital heart disease, history of prematurity, patient admitted with chronic respiratory illness like bronchopulmonary dysplasia, congenital cystic malformation, malnutrition and previous treatment with oxygen for the index illness.

Eligible patients were evaluated clinically at admission. The patients were accompanied by their mothers/care givers. After a period of adjustment for at least 5 minutes, and with the child quiet, not crying, without fever and breathing room air only, principal investigator evaluated the severity of the acute wheezing episodes using a Modified Tal's clinical score (Table I). The respiratory frequency was determined by observing the thoracic movement over a full minute. The degree of accessory muscle used was based on the degree of intercostals or subcostal retraction. Simultaneously, the researcher measured SpO_2 by shenzen aeon pulse oximeter model: A360 by placing soft rubber sensor probe on left big toe when the child was quite and awake. The maximum SpO_2 recorded after a period of at least three satisfactory sweeps of the pulse wave was recorded (Corroborating that the cardiac frequency of the oximeter coincided with the simultaneously taken heart rate byauscultation).

Table I Modified Tal score[2,6]

Score	Respiratory rate (Per min)		Wheezing	Cyanosis	Accessory Muscle use
	<6 Months	≥6 Months			
0	40	30	None	None	None
1	41-55	31-45	End expiratory with stethoscope	Peri-oral on crying only	+
2	56-70	46-60	Inspiration and expiration with stethoscope	Peri-oral at rest	++
3	>70	>60	Audible without stethoscope	Generalized in rest	+++

Data were processed and analyzed with Statistical package for social science Windows version 23. Descriptive statistics summarize observations and describe the study subjects' characteristics. Categorical variables were expressed as frequency and percentage. Quantitative data were expressed in median (Interquartile range) or mean ±Standard Deviation (SD). A one-way analysis of variance tested the mean differences of the SpO_2 level between different MTS categories. The Pearson correlation coefficient test determined the correlation between SpO2 level and MTS and its components score. A simple linear regression model between SpO_2 and clinical score was also determined. The receiver operating characteristics curve was plotted to determine the MTS score's ability to discriminate hypoxaemia from children without hypoxaemia. The best cutoff point for the MTS was calculated, and sensitivity, specificity, positive and negative predictive values were calculated. Statistical significance was defined as $p < 0.05$.

RESULTS

Within the study period a total of 251 children with bronchiolitis were included in the study. The majority (61.8%) of patients were less than six months of age with rage between 1 month and 22 months. Male preponderance was present, with the overall male to female ratio being 1.64:1. The maximum number of patients (152/251) was from rural areas (Table II).

Table II Demographic characteristics of the patients (n=251)

Variables		Frequency	Percentage
Age, months	<6 months	155	61.8
	≥6 months	96	38.2
	Mean ±SD	5.9±5.1	
Sex	Male	151	60.2
	Female	100	39.8
Residential location	Urban	99	39.4
	Rural	152	60.6

SD: Standard Deviation.

The typical presentation of bronchiolitis such as cough, running nose and respiratory distress was present in the entire group (100%). More than 90% of cases had the complaint of fast breathing. Other less frequently reported complaints were poor feeding (11.6%) lethargic child (7.6%) and constant cry (3.6%). Typical signs of bronchiolitis such as wheeze, chest indrawing (Mild 37.8%, moderate 39.1%, and severe 23.1%), and fast breathing were present in the entire group (100%). More than half of the cases (59.8%) had nasal flaring. Cyanosis and grunting were observed in 7.2% and 3.6% of the patients.

SpO_2 of the studied patients ranged from 70% to 99%, with a median value of 95%. More than half (51%) of the patients had a SpO_2 value of ≥95%. In the present study, hypoxaemia was defined as SpO_2<90%. According to this cut off value, less than one fourth (23.5%) of the patients had hypoxaemia.

MTS ranged between 2 to 12 in the studied patients, with a mean value of 5.59±2.29. Maximum number of the studied patients falls in mild category (140/251, 55.8%) as per modified Tal clinical score. Only 4 (1.6%) of the patients were categorized as having very severe disease as per the clinical score.

The correlation coefficient between total clinical score and SpO_2 was r=-0.82 ($p < 0.001$). The correlation of each component of the clinical score and SpO2 was also significant ($p < 0.001$): wheezing r= -0.693, cyanosis rho= -0.388, accessory muscle use r= -0.662, and respiratory frequency r= -0.622.

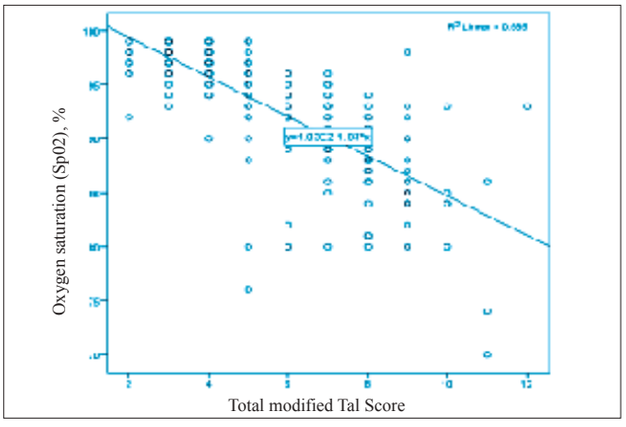

Figure 1 Scatter Dot plot showing correlation and linear regression model between clinical score and SpO_2

Simple linear regression was carried out to investigate the relationship between SpO_2 and MTS. The scatter plot showed a strong negative linear relationship between the two, which was confirmed with a Pearson's correlation coefficient of 0.820 (Table IV). Simple linear regression showed a significant relationship between SpO_2 and MTS ($p < 0.001$). The slope coefficient for MTS was -1.83. So, the SpO_2 decreased by -1.83% for each extra point of MTS. The R^2 value was 0.585, so 58.5% of the variation in SpO_2 can be explained by the model containing only MTS. The linear regression model between SpO_2 and MTS was: y (SpO_2) = 103.046 -1.83 x (MTS) (Figure 1).

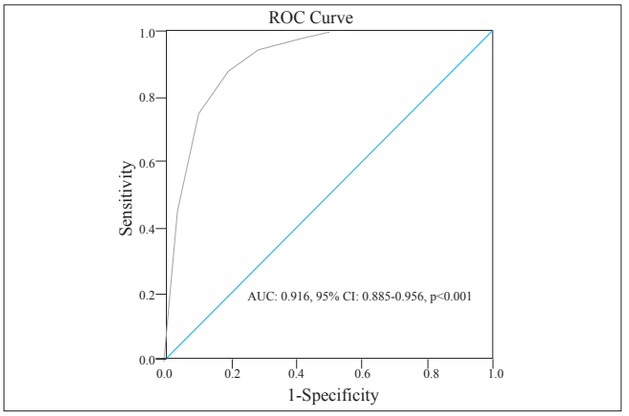

Figure 2 Receiver Operating Characteristics (ROC) Curve showing ability of the modified Tal clinical score to predict hypoxaemia

Figure 2 shows that clinical score has good predictive ability in discriminating children with hypoxaemia from the children without [Area under the curve (AUC): 0.916, 95% CI: 0.885-0.956, p<0.001]. With the cutoff value of ≥6, the clinical score had 96.61% sensitivity, 71.88% specificity and 98.57% negative predictive value to detect hypoxaemia (SpO_2<901%).

The mean (± SD) SpO_2 value was 96.3±2.4% in children with a score of 2-5, 90.65±5.6% in those with a score of 6-7 and 86.6±4.7% in children with a score of 8 or more ($p < 0.001$ by Bonferroni's multiple comparisons, when all two-way comparisons were done for each pair of results; Table III). Similar trends of the mean SpO_2 values were observed in both age groups.

Table III Average SpO_2 by clinical score and age group

TAL's score	SpO_2					
	Total		Age <6 months		Age≥6 months	
	Mean ±SD	n	Mean ±SD	n	Mean ±SD	n
2-5	96.3±2.4	140	96.4±2.6	105	95.9±2.0	35
6-7	90.65±5.6	48	90.7±4.1	23	90.6±5.1	25
≥8	86.6±4.7	63	87.0±3.9	27	86.3±5.3	36
p value*	<0.001		<0.001		<0.001	

*One-way analysis of variance (ANOVA) test. When all two-way comparisons were done for each set of pairs in each age group and the entire group, SpO2 for all pairs was significantly different ($p < 0.01$ corrected for Bonferroni's multiple comparisons).

DISCUSSION

The present study used modified TAL's score to evaluate the severity of acute wheezing episodes in bronchiolitis infants. In the study, 251 patients with acute bronchiolitis were included from a tertiary level hospital of Chattogram Bangladesh. The SpO_2 determined by pulse oximeter is the single best objective predictor of severity in infants with acute bronchiolitis and was chosen as the gold standard in this study.[16] The severity of acute bronchiolitis is closely related to hypoxaemia and hyperpnoea arising from an abnormal ventilation distribution relative to perfusion. This study showed a significant correlation between modified TAL scores and SpO_2.

The present study showed a better correlation when considering the clinical score as a whole instead of each isolated score element. The study demonstrated a strong negative correlation (r= 0.82; 95% CI, -0.857 to -0.775, $p < 0.001$) between MTS and SpO_2. A single clinical sign will not indicate the severity of airway obstruction, but a combination of signs may provide more valid information. The present study findings agreed with the the previous studies where correlation coefficient of was -0.76 and 0.734.[12,13] The good correlations found in the present study, the previous studies were due, in part, to the fact that only one investigator evaluated the clinical score in all patients, in contrast to other study where there were several observers with wide variations in scoring between them.[12-14]

The present study also investigated the correlation of each component of the modified TAL score and SpO_2, which were also statistically significant. Similar results were shown by Pavo´n et al and Shete et al.[12,13] McCallum et alfound that the internal consistency of the modified TAL scoring system was good. All components of the score contributed significantly to the overall score. Other than respiratory rate, the other components exceeded the cutoff of 0.6.[2]

Accessory muscle utilization is a useful parameter in evaluating the severity of airway obstruction and predicting the need for oxygen supplementation.[17] Previous studies reported the highest correlation for accessory muscle use.[12,13] The current study also confirmed that the degree of accessory muscle use (i.e. degree of intercostal or subcostal retractions) had the best correlation with hypoxemia (r= 0.662, $p < 0.001$). It was postulated that chest recession reflects the effort to improve oxygenation in hypoxaemic children with a lower respiratory infection. For this reason, probably accessory muscles had been shown to correlate strongly with the severity of the disease.[16] In contrast, Mulholland et al. did not find a correlation between this sign and SpO_2, perhaps due to more severe airway obstruction in their population.[18]

The correlation for respiratory rate and wheezing were less than accessory muscle use in the current study. The correlation of SpO_2 with the cyanosis was the lowest. This may be because skin colour is affected by many factors besides peripheral tissue perfusion and oxygenation. Cyanosis, which only occurs in children with severe hypoxemia, may not be easily detectable in anaemia and dark pigmentation.[19] In addition, Pavón et alobserved that the item cyanosis in the MTS showed a weak correlation to saturation.[12] This was consistent with the observations of another study, which showed that cyanosis was not correlated to the reference standard.[20]

Concerning predictive validity, results showed an association between the TAL's score and the probability of having hypoxaemia, thus suggesting that the clinical score may be capable of predicting the probability of hypoxaemia. The AUC was 0.916. Fan et al. stated that an AUC of ≥0.75 is clinically relevant.[21] This was consistent with the results obtained by Duarte-Dorado et alwho showed that the higher severity score in a bronchial obstruction scale similar to the modified TAL score - which included saturation, wheezing, retractions, and connection to the environment as items– was associated with a greater need for hospitalization.[22]

A modified TAL's score ≥6 was found to have a sensitivity of 96.61%, specificity of 71.88% and negative predictive value of 98.57% to detect hypoxemia (Spo_2<90%). In the study of Pavón et ala higher score (≥8) than the current study was found to have a sensitivity of 100%, specificity of 86.4%, and a negative predictive value of 100% in diagnosing hypoxemia (Spo_2 ≤91%).[12] The difference between these two studies is probably due to the different definitions of hypoxaemia.

There is a decrease in the mean SpO2 values with the increase in severity from mild to severe as per clinical severity score in the whole group and each age group. On application of ANOVA, the p-value obtained was highly statistically significant (p-value < 0.001), denoting that mild and severe classes of TAL system are highly positively correlated with SpO_2 level, so as the severity group in TAL's category will increase so the mean oxygen saturation will decrease. A similar observation was also reported in previous studies.[12,13]

LIMITATIONS

The present study has several limitations, including the relatively small number of enrolled patients, and the single-center design. Further limitation is that raters were pediatricians; therefore, our findings may not be generalized to other caregivers, such as general physicians, nurses, and respiratory therapists. However, as the MTS can be easily used with minimal previous training, we speculate that other caregivers can use it with no further training.

CONCLUSION

It can be concluded that for children one month to 24 months, modified TAL's clinical scoring system strongly correlates with the SpO_2. Modified Tal's clinical score can be used as a primary tool to confirm the severity of hypoxemia in infants with acute bronchiolitis even if pulse oximetry is not available. Future studies should simultaneously assess various other clinical scoring methods so that the best clinical score method would have been identified.

DISCLOSURE

All the authors declared no competing interest.

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