

## Predictors of Outcome of Bronchiolitis in Children Using Children Hospital of Wisconsin Respiratory Score: An Experience of a Tertiary Care Hospital

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### ABSTRACT

**Objective:** To study the correlation of CHWR score and its various clinical markers with the length of stay in hospital bronchiolitis.

**Study Design:** Cross-sectional analytical study.

**Place and Duration of Study:** Department of Pediatrics Combined Military Hospital, Lahore Pakistan, from Nov 2018 to Apr 2019.

**Methodology:** This study included children aged 2 to 24 months, clinically diagnosed with bronchiolitis. The Receiver Operator Characteristic (ROC) was used to determine the discriminative validity of the CHWR score in predicting the length of stay.

**Results:** One hundred thirty-eight children of either gender were enrolled in the study. The median age of the study population was 10.8 (9) months. ROC curve showed significant discriminative validity of CHWR score and its component criterion on admission. CHWR score of >10.5 predicted a longer stay (>24 hours) in ICU. Pearson correlation showed a statistically significant positive correlation between CHWR score at admission and length of stay ( $r=0.831$ ,  $p<0.001$ ).

**Conclusion:** CHWR scoring system on admission is an easy, safe and effective way to classify bronchiolitis severity and thus help predict the length of stay.

**Keywords:** Bronchiolitis, Children's hospital of Wisconsin respiratory score (CHWR), Length of stay.

**How to Cite This Article:** Ahdi SG, Nadeem T, Farrukh H, Saleem F, Gul R, Khalid H. Predictors of Outcome of Bronchiolitis in Children Using Children Hospital of Wisconsin Respiratory Score: An Experience of a Tertiary Care Hospital. *Pak Armed Forces Med J* 2023; 73(1): 223-226. DOI: <https://doi.org/10.51253/pafmj.v73i1.4857>

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### INTRODUCTION

Bronchiolitis is an inflammation of bronchioles resulting in increased respiratory effort and wheezing. Pathological features of the disease are acute inflammation, increased mucus production and oedema of small airways leading to bronchospasm.<sup>1</sup> It is a viral disease caused mainly by RSV, influenza-A, influenza-B, para-influenza, and adenovirus.<sup>2</sup> Children aged 2-24 months are the most vulnerable group with documented bronchiolitis.<sup>3</sup> Bronchiolitis is usually a self limiting disease and often needs minimal intervention.<sup>4</sup> It is usually diagnosed on a clinical basis with history & physical examination, requiring no extensive investigations.<sup>5</sup>

Bronchiolitis is a disease with high morbidity but low mortality. Death from respiratory failure in bronchiolitis is rare and ranges for RSV bronchiolitis from 2.9(UK) to 5.3(USA) deaths per 100000 children below 12-months.<sup>6</sup> Complications in a severe variety of diseases include otitis media, apnea, respiratory failure, superadded bacterial infection, pleural effusion and pneumothorax.<sup>6</sup>

A number of different respiratory scores can be

found in the literature to assess the severity and monitor treatment response.<sup>7</sup>

Children's Hospital of Wisconsin Respiratory Score (CHWR) is one of these scoring systems to assess the severity of bronchiolitis using eight respiratory parameters, including breath sounds, dyspnea, chest retractions, heart rate, respiratory rate, oxygen need, activity or appearance, cough ability or secretions along with chest X-ray findings and surgical status.<sup>8,9</sup> Each parameter has been assigned a specific score ranging from 0-3 according to severity.<sup>10</sup>

Our study aimed to evaluate the ability of CHWR and its component parameters to predict the length of hospital stay of children admitted to a tertiary care hospital with bronchiolitis. On admission, children with the more severe disease are likely to have high CHWR and longer stay in the hospital.

### METHODOLOGY

The cross-sectional analytical study was conducted at Paediatric Intensive Care Unit (PICU), Combined Military Hospital, Lahore Pakistan, from November 2018 to April 2019 after receiving ethical approval from IRB and informed consent from parents. The sample size was calculated by the WHO sample size calculator with 7-10% prevalence of respiratory dist-

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Received: 27 Jul 2020; revision received: 12 Jun 2022; accepted: 14 Jun 2022

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ress in paediatric ED.<sup>11</sup> Non-probability consecutive sampling technique was used for data collection.

**Inclusion Criteria:** All children of either gender, aged 2 to 24 months clinically diagnosed with bronchiolitis were enrolled in this study.

**Exclusion Criteria:** Children with underlying congenital heart disease, bronchopulmonary dysplasia, pneumonia, cystic fibrosis, neurological disorder and/or concomitant other illness like sepsis, meningitis and diarrhoea were excluded from the study.

All children admitted with the diagnosis of bronchiolitis in PICU were assigned a specially designed Performa, and all demographic variables, along with diagnostic data required for CHWRS criterion, were assessed and recorded by paediatric residents. Before starting data collection, the PICU team, including residents and nurses, were trained and assessed for uniformity of data collection. In addition, we documented the outcome of every patient as a short/long length of stay in the hospital. The length of stay was defined as short if it was 24 hours or less and long if admitted for >24 hours.<sup>12</sup>

The data were analyzed using SPSS-23.00 and MS Excel 2019 software. Mean±SD/Median (IQR) was calculated for the continuous variable. Frequency and percentage were calculated for categorical variables. The Pearson correlation coefficient 'r' was calculated to determine the strength and direction of correlation between the CHWR score and its individual parameters at admission and length of stay. The ROC was used to determine the discriminative validity of the CHWR score and its components in predicting the length of stay. The *p*-value of ≤0.05 was considered significant.

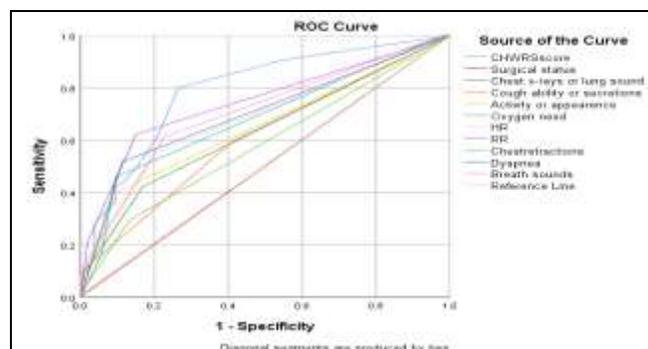
### RESULTS

One hundred thirty-eight children were enrolled in this study. There was male preponderance, with 80 (58%) boys compared to 58(42%) girls. The median age was 10.5(9) months (Table-I).

**Table-I: Demographic characteristics (n=138)**

Characteristic	n(%)
<b>Gender</b>	
Female	58 (42%)
Male	80 (58%)
<b>Age (Months)</b>	
Median (IQR)	10.5 (9) months
Range	2-24 months
<b>Length of stay (Hours)</b>	
Mean	40.09±23.64 hours
Shorter stay	53 (38.4%)
Longer stay	85 (61.6%)

ROC(Receiver Operating Characteristic Curve) was constructed for the CHWRS score and individual para-meters on admission and length of stay (Figure).



**Figure: ROC Curve for CHWRS and Its Individual Parameters Predicting Length of Stay (n=138)**

The area under the curve was 0.792 with a cutoff point of 9.5 as a CHWR score of >10.5 predicting longer stay (>24 hours) in the intensive care unit. Its sensitivity was 80.0%, and its specificity was 73.6%. The area under cover, std. error, asymptotic sig and confidence interval for CHWRS & its individual parameters predicting length of stay were shown in Table-II.

**Table-II: CHWR Score and its Individual Parameters predicting Length of Stay (n=138)**

Test Result Variable(s)	Area Under Cover	STD. Error	<i>p</i> -value	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
CHWRS score	0.792	0.040	<0.001	0.713	0.871
Surgical status	0.502	0.051	0.963	0.403	0.602
Chest x-rays or lung sound	0.633	0.047	0.009	0.540	0.725
Cough ability or secretions	0.612	0.048	0.027	0.517	0.707
Activity or appearance	0.653	0.046	0.003	0.562	0.744
Oxygen need	0.682	0.046	<0.001	0.593	0.771
HR	0.681	0.045	<0.001	0.592	0.770
RR	0.746	0.042	<0.001	0.665	0.828
Chest retractions	0.582	0.049	0.107	0.486	0.678
Dyspnea	0.702	0.044	<0.001	0.615	0.789
Breath sounds	0.707	0.045	<0.001	0.619	0.794

Pearson correlation showed a statistically significant positive correlation between CHWR score at admission and length of stay ( $r=0.831$ ,  $p<0.001$ ), as depicted in Table-III. For admitted children, the mean length of stay was  $40.09\pm 23.64$  hours. Short stay ( $\leq 24$  hours) was observed in 53(38.4%) children as compared to 85(61.6%) children with longer stay and was statistically significant ( $p<0.001$ ).

**Table-III: Correlation of CHWR Score and Individual Parameters with Length of Stay (n=138)**

Factors	Pearson Correlation Co-efficient (r) and p-value
<b>CHWRS score at admission</b>	
Pearson Correlation Co-efficient	0.831
p-value	< 0.001
<b>Dyspnea</b>	
Pearson Correlation Co-efficient	0.675
p-value	< 0.001
<b>Breath sounds</b>	
Pearson Correlation Co-efficient	0.666
p-value	<0.001
<b>Retractions</b>	
Pearson Correlation Co-efficient	0.549
p-value	<0.001
<b>Respiratory Rate</b>	
Pearson Correlation Co-efficient	0.763
p-value	<0.001
<b>Heart Rate</b>	
Pearson Correlation Co-efficient	0.549
p-value	<0.001
<b>oxygen need</b>	
Pearson Correlation Co-efficient	0.680
p-value	<0.001
<b>Surgical Status</b>	
Pearson Correlation Co-efficient	0.202
p-value	0.018
<b>Activity or appearance</b>	
Pearson Correlation Co-efficient	0.751
p-value	<0.001
<b>Cough or Secretions</b>	
Pearson Correlation Co-efficient	0.557
p-value	<0.001
<b>Chest X-rays or Lung sounds</b>	
Pearson Correlation Co-efficient	0.646
p-value	<0.001
<b>Length of stay</b>	
Pearson Correlation Co-efficient	1.00
p-value	

## DISCUSSION

CHWR scoring system on admission is an easy, safe and effective way to classify bronchiolitis severity and thus help predict the length of stay. Acute bronchiolitis primarily affects children less than two years of age. The median age of children in our study was 10.8 months, similar to previous studies. Hemalatha *et al.* found bronchiolitis commonly occurring in the age group <1 year.<sup>12</sup> Another study by Iqbal *et al.* found a mean age of 11.3±5 months.<sup>13</sup>

We found CHWRS to have a good predictive ability with the area under the ROC curve of 0.792. This area under the curve is an expression of the overall accuracy of a model and is a good measure of its

predictive ability. A previous study also reported CHWRS as a good predictive marker with an area under the ROC curve of 0.687.<sup>14</sup> We evaluated different CHWRS components to observe their association with the severity of the disease and predict the length of stay. According to our study, tachypnea, breath sounds, tachycardia and lung sounds at admission were statistically significant factors in predicting length of stay. Among the individual components in our study, tachypnea has been most significant and independently correlated with the indication of the severity of bronchiolitis and thus prolonged the hospital stay. These findings were in line with the studies by Destino *et al.* Iqbal *et al.* and Weisgerber *et al.* which have documented that tachypnea was the most common presentation in children with bronchiolitis and was found to be associated with the severity of the disease.<sup>7-14</sup>

In bronchiolitis, extra respiratory sounds are heard due to the narrowing of bronchioles due to inflammation, oedema and mucus formation. On auscultation, crackles, rales or wheezes may be found in one or both phases of breath sounds. In severe cases, we may also encounter a silent chest. Destino *et al.* Weisgerber *et al.* and Ojha *et al.* documented that inspiratory wheeze is significant in assessing the severity of bronchiolitis and length of stay.<sup>7,14,15</sup> In our study, wheezing, both in inspiratory and expiratory phases of breath sounds, at the time of admission was indicative of severe disease and predicted a longer stay.

Previous studies revealed that oxygen requirement is a dominating factor and significantly correlates with hospital admission.<sup>16,17</sup> We also found in our study that Oxygen requirement at the time of admission was statistically significant as an outcome predictor and was associated with increased length of stay. In addition, excessive cough at admission is associated with a longer stay in the hospital.<sup>15-17</sup> This was in congruence with our results. Tachycardia has been documented as a significant feature of acute bronchiolitis.<sup>7,17,18</sup> In our study, we found that tachycardia was a persistent feature of all the children with acute bronchiolitis who had high CHWRS and needed admission. They also ultimately needed prolonged hospital stays.

In our study, the mean length of stay was 40.09 hours, comparable to the mean hospital stay of 42 hours documented in a study by Mussman *et al.*<sup>19</sup> and 49.3 hours in a study by Sandweiss *et al.*<sup>20</sup>

It has shown that a high CHWR score on admission is significant in predicting disease severity and,

thus, longer stays in the hospital. In addition, our analysis has shown a moderate correlation between CHWR score at admission and length of stay, which was statistically proven significant.

### LIMITATIONS OF STUDY

The limitation of this study was that we studied the correlation of only single values of the CHWR score and its parameters with the length of stay in the hospital.

### CONCLUSION

CHWR scoring can be quickly calculated and is an easy, safe and effective way of assessing and anticipating the severity of acute bronchiolitis. The scoring will aid in the stratification and prioritization of the patients. In addition, it can help the paediatrician utilise the resources effectively in managing patients and improving the outcome.

**Conflict of Interest:** None.

### Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SGA & MTN: Conception, study design, drafting the manuscript, approval of the final version to be published.

HF & FS: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

RG & HK: Critical review, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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