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ORIGINAL ARTICLE

Study of Three Prognostic Clinical Scoring Systems for Bronchiolitis in Hospitalized Infants

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ABSTRACT

Background: In order to evaluate the respiratory assistance required for the cases and forecast the patient's outcome, numerous studies have been developed to categorize the severity of bronchiolitis in newborn infants based on the clinical presentation and level of respiratory distress. In order to provide respiratory care for infants under one year old who have bronchiolitis, we aimed to evaluate the clinical benefits of the Wang Bronchiolitis Severity Score (WBSS), Global Respiratory Severity Score (GRSS), and Kristjansson respiratory score (KRS) based on their severity level.

Methods: This Prospective Cohort Study was conducted at Zagazig University hospital on 40 infants hospitalized with bronchiolitis. WBSS, GRSS and KRS were assessed in all cases.

Results: WBSS revealed that 92.5% of patients had abnormal appearances, with a mean score of 7.9 ± 2, indicating moderate to severe respiratory distress. The KRS showed that 77.5% of patients had a moderately affected appearance, with a mean score of 4.6 ± 1.48, reflecting moderate severity. The GRSS, with a mean score of 5.3, found mild to moderate respiratory distress in the majority of patients. These scoring systems provided strong predictive capabilities for respiratory distress, with WBSS, KRS, and GRSS scores correlating with the need for respiratory support.

Conclusion: These scores reliably identify patients at higher risk for respiratory compromise, with higher scores correlating strongly with the need for respiratory interventions and longer hospital stays. Notably, the GRSS showed the highest predictive accuracy for respiratory support and ICU admission.

Keywords: Clinical Scoring Systems, Bronchiolitis, Hospitalized Infants.

INTRODUCTION

One of the most frequent causes of respiratory distress in infants under one year old worldwide is acute viral bronchiolitis. [1

Approximately 3% of infants to 12-month-olds are hospitalized due to bronchiolitis. The Respiratory Syncytial Virus is the cause of bronchiolitis in the majority of hospitalized infants [2].

Symptoms of bronchiolitis typically start as rhinitis or develop into respiratory distress. Numerous risk factors, including immunodeficiency, congenital cardiac disorders, and preterm newborns, can exacerbate the severity of the illness [3].

In order to offer the proper respiratory assistance required, bronchiolitis is classified as mild, moderate, or severe based on a number of criteria, including the degree of respiratory distress, pre-existing risk factors, and prior clinical history [4].

Recent research has used various clinical scores, including the Wang Bronchiolitis Severity Score (WBS), Kristjansson Respiratory Score (KRS), Respiratory Distress Assessment Instrument (RDAI), Modified Tal score, and TAL score, to measure the severity of bronchiolitis and track the course of cases [4].

The Wang Bronchiolitis Severity Score (WBSS), Kristajansson Respiratory Score (KRS) as well as Wang EEL et al. (1992) are numerous clinical severity scores that have been reported to measure the severity of bronchiolitis [4].

In order to predict the severity of respiratory syncytial virus (RSV) infections in babies, the Global Respiratory Severity Score (GRSS) was developed in 2017. It is an algorithm-based score that takes into account both general and age-specific respiratory characteristics [5].

The GRSS score is the most useful scoring system to distinguish the respiratory support required for young children (up to 10 months) infected with the Respiratory Syncytial Virus, according to a recent study by Kubota et al. [6].

METHODS

The children hospital at Zagazig University served as the site of this prospective cohort study. Forty infants who were hospitalized with bronchiolitis participated in this study. Infants' parents or guardians gave their informed permission. The Zagazig University Faculty of Medicine's ethical committee gave its approval to the investigation (IRB number 11238-31-10-2023).

Infants hospitalized with bronchiolitis with age up to 12 months were included. The exclusion criteria was as follow: the gestational age was less than 36 weeks at birth, only admitted for apnea, high-risk conditions, including as neurological disorders, immunosuppression, cancer, congenital heart disease, and chronic aspiration, palivizumab prophylactic indication, the background of wheezes and the use of steroids for treatment.

Measurements of oxygen saturation frequently reveal lower saturation levels and signs of dehydration, which may be present if respiratory distress has been severe enough to interfere with feeding. All patients underwent a thorough history taking, general and local examinations, and a special focus on increased respiratory rate, signs of respiratory distress, crackles, and wheezing on auscultation.

Classify cases according to level of severity;

Based on admission clinical data, we computed clinical severity scores (WBSS, KRS, and GRSS). The four categories that make up the WBSS (Wang Bronchiolitis Severity value) are respiratory rate, general appearance, wheezing, and retractions. Each item has a value between 0 and 3 with the exception of general appearance which only receives a score 1 and 3. The total score ranges from 0 to 12. Respiratory rate, general look, wheezing, retractions, and skin color are the five indicators that make up the Kristjansson Respiratory Score (KRS), which ranges from 0 to 10. In an interactive tool, 10 parameters—age, oxygen saturation, respiratory rate, general appearance, wheezing, rhales and rhonchi, retractions, skin tone, lethargy, and poor air movement—are entered to determine the GRSS (Global Respiratory Severity Score) **[4, 5, 7].**

Follow up and outcome measurements

To ascertain the outcome and duration of hospital stay, follow up on cases until they are discharged. The need for respiratory support—either mechanical ventilator, nasal continuous positive airway pressure, or a high-flow nasal cannula—was the main consequence. The number of days spent in the hospital was the secondary outcome.

Management of bronchiolitis during hospitalization

In accordance with the most recent guidelines and evidence from the literature, our units employed intravenous fluid therapy, superficial nasal suction, and nebulized 3% hypertonic saline solution. When the clinical circumstances were suitable for enteral feeding, the amount of intravenous fluid treatment was quickly reduced. High-flow nasal cannulas (HFNCs) were used as the primary respiratory support for patients whose saturation levels remained below 92% and who showed signs of respiratory distress (tachypnea, chest retractions, etc.) or respiratory acidaemia on the venous blood gas analysis. We administer a flow rate of 2 liters/minute per kilogram of body weight, starting at 4 liters/minute and going up to 10 liters/minute. For patients exhibiting clinical deterioration, we employed mechanical ventilation or nasal continuous positive airway pressure (nCPAP) as rescue measures. Positive end-expiratory pressure (PEEP), in the context of nCPAP, was set between 5 and 7 cmH20.

Statistical Analysis:

SPSS version for Windows and Microsoft Excel version 7 (Microsoft Corporation, NY, USA) were used for all statistical computations. Chicago, IL, USA-based SPSS (Statistical Package for the Social Sciences) Inc. Fisher's exact test, Chi square ($\chi 2$) test, Student T-test, and Paired T-test were employed.

RESULT

Based on patient characteristics, the mean gestational age was 38.27±0.8 weeks, the mean weight at admission was 6.76±1.7 kg, and the mean age was 4.52±2.9 months. There were 13 patients (32.5%) who were female and 27 patients (67.5%) who were male. According to the admission examination, the majority of patients 14 (35%), in terms of general appearance, had poor nutrition, and the majority of patients 25 (62.5%) had RD II. Thirty-two (80%) of the patients had normal skin, eight (20%) exhibited pallor, and none had cyanosis. Three patients (7.5%) exhibited severe nasal flaring, nine (22.5%) had tracheostrenal retraction, and eighteen (45%) had intercostal muscle retraction. 24 patients (60%) experienced wheezes (entire expiration), 12 patients (30%) experienced wheezes (terminal expiration), and 4 patients (10%) had wheezes (inspire expiration) during auscultation. The mean respiratory rate (breath/min) was 57.5±5.71 and the mean O2 saturation (%) was 94.05±1.3. Five patients (12.5%) experienced lethargy, eleven (27.5%) had good air entry, and 29 (72.5%) had poor air entry (**Table 1).**

Three patients (7.5%) had normal appearances, while 37 patients (92.5%) had abnormal appearances based on the Wang Bronchiolitis Severity Score (WBSS). Of them, 1 (2.5%) had a respiratory rate between 30 and 45 breaths per minute, 28 (70%) had a respiratory rate between 46 and 60 breaths per minute, and 11 (27.5%) had a respiratory rate greater than 60 breaths per minute. In terms of muscle retraction, intercostal muscle retraction was present in the majority of individuals. The majority of patients exhibited full expiration or audible expiration without a stethoscope in terms of auscultation. The mean for the overall score was 7.9±2 (Table 1 Supplementary).

Three patients (7.5%) had normal appearances, thirty-one (77.5%) had moderately affected appearances, and six (15%) had severely affected appearances, based on the Kristjansson respiratory score. Of them, 11 (27.5%) had a respiratory rate greater than 60 breaths per minute, while 29 (72.5%) had a respiratory rate between 40 and 60 breaths per minute. There were eleven (27.5%) individuals with pallor skin and 29 (72.5%) individuals with normal skin color. The majority of individuals experienced considerable muscular retraction in this aspect. In terms of auscultation, five (12.5%) of them had wheezes. The mean score for the entire score was 4.6±1.48 (Table 2 Supplementary).

Based on the Respiratory Severity Score, 19 patients (47.5%) had mild appearance, 17 patients (42.5%) had moderate look, and 4 patients (10%) had severe appearance. None of the patients developed cyanosis in terms of skin color. The majority of patients (77.5%) exhibited respiratory muscle retraction. All patients underwent auscultation; six (15%) of them showed signs of lethargy, and 31 (77.5%) showed signs of air entery. The mean O2 saturation was 93.02±6.6 and the mean respiratory rate was 58.5±7.9 (Table 3 Supplementary).

37.5% of cases required respiratory support, whereas 62.5% did not. Of the 15 cases who required respiratory support, 53.3% were on HFNC, 13.3% were on CPAP, and just two required MV. Two patients (5%) had no antibiotics, whereas 16 patients (40%) received cefotaxime, 13 patients (32.5%) had ampicillin, 1 patient (2.5%) had both cefotaxime and ampicillin, 1 patient (2.5%) had ceftazidime, and 1 patient (2.5%) had cefepime. 40 individuals (100%) had ipratropium, a corticosteroid, in relation to nebulizers. Forty patients (100%) required intravenous fluid (Table 4 Supplementary).

According to outcome, there was 30 (75%) of patients had no complications, while 10 (25%) of patients had RD III. Who needed ICU admission eiher NICU or PICU, finally all patients were improved with Mean of hospital stay of 4.9±1.4 days (Table 2).

The median WBSS, KRS, and GRSS score was significantly higher in cases with respiratory support (9, 5, and 8 respectively) than in cases without respiratory support (median = 7, 4, and 4 respectively). When comparing hospital length of stay between cases with and without respiratory support, the mean hospital stay for cases with respiratory support was significantly longer (6.2 days) than for cases without (4.2 days), indicating that the results were highly statistically significant (p value <0.01). (Table 3).

Regarding the comparison between cases who needed different types of respiratory support regarding WBSS, KRS and GRSS score, the results was statistically significant (p value <0.05) as median of these scores was significantly higher among cases who needed mechanical ventilation, then among cases who were on CPAP than cases who were on HFNC (Table 4).

The findings of the ROC curve analysis for the WBSS, KRS, and GRSS scores for predicting the need for respiratory support were as follows: For WBSS, the sensitivity and specificity for predicting the need for respiratory support when the cutoff value was greater than 8.5 were 80% and 92%, respectively, with an AUC of 0.91 and a total accuracy of 87.5%. Additionally, the p value was significant at the level <0.05. When the cut-off value was more than 4.5, KRS's sensitivity and specificity for predicting the requirement for respiratory support were 86.7% and 88%, respectively, with an AUC of 0.908 and a total accuracy of 87.5%. The p-value was significant at the level <0.05. When the cutoff value was more than 5.5, GRSS's sensitivity and specificity for predicting the requirement for respiratory support were 87% and 92%, respectively, with an AUC of 0.94 and a 90% overall accuracy. The p-value was significant at the threshold <0.05 (Table 5).

According to the findings of the ROC curve analysis for WBSS, KRS, and GRSS score for predicting the need for ICU admission, WBSS had a sensitivity and specificity of 80% for predicting the need for ICU admission when the cutoff value was greater than 8.5, with an AUC of 0.86 and a total accuracy of 80%. Additionally, the p value was significant at the level <0.05.

With an AUC of 0.91 and a total accuracy of 80%, KRS demonstrated sensitivity and specificity of 90% and 97%, respectively, for predicting the requirement for ICU admission when the cutoff value was more than 4.5. Additionally, the p-value was significant at level <0.05. With an AUC of 0.94 and a total accuracy of 90%, GRSS demonstrated 90% sensitivity and specificity in predicting the requirement for ICU admission when the cutoff value was more than 6.5. Additionally, the p-value was significant at the level <0.05. (Table 6).

There is a somewhat positive association between hospital stay and WBSS score (r=0.57), and the results were statistically significant (p value <0.05) for the link between hospital stay and both WBSS, KRS, and GRSS score among children who required NICU admission. Additionally, hospital stay and both KRS and GRSS scores have a moderately favorable connection (r=0.72 and 0.51, respectively), suggesting that longer hospital stays will be linked to higher overall scores for both parameters (Table 7).

Table (1): Distribution of baseline data in the studied patients.

	Studied patients (N=40)	
	Mean	**±SD**

	Studied patients (N=40)	
	Mean	**±SD**
Age (months)	4.52	2.9
Weight on admission(kg)	6.76	1.7
Gestational age(wks)	38.27	0.8
Sex	**N**	**%**
male	27	67.5%
female	13	32.5%
Examination		
RD I	12	30 %
RD II	25	62.5 %
RD III	3	7.5 %
General appearance		
normal	3	7.5 %
poor nutrition	14	35 %
irritable	11	27.5 %
lethargy	3	7.5 %
poor nutrition +lethargy	1	2.5 %
poor nutrition + toxic	1	2.5 %
Irritable+ poor nutrition	2	5 %
Refusal of feeding	2	5 %
Irritable+ refusal of nutrition	2	5 %
dyspnea	1	2.5 %
Skin color		
normal	32	80 %
pallor	8	20 %
Respiratory muscle retraction		
no	10	25 %
supra-strenal	9	22.5 %
intercostal	18	45 %
Severe nasal flaring	3	7.5 %
Auscultation		
wheezes (entire expiration)	24	60 %
wheezes (terminal expiration)	12	30%
Wheeze (inspiration expiration)	4	10 %
Lethargy		
Yes	5	12.5 %
No	35	87.5 %
Air entry		

	Studied patients (N=40)	
	Mean	**±SD**
good	11	27.5 %
poor	29	72.5 %
	Mean	**±SD**
Respiratory rate (breath/min)	57.5	5.71
O2 saturation (%)	94.05	1.3

SD: stander deviation.

Table (2): Distribution of outcome in the studied patients.

	Studied patients N=40	
	N	**%**
ICU admission		
No	30	75%
Yes	10	25%
Complications		
No	30	75%
RD III	10	25%
Outcome		
Improved Died	40 0	100% 0%
	Mean	**±SD**
Hospital stay (days)	4.9	1.7

ICU: intensive care unit.

Table (3): comparison between cases who need respiratory support and cases without respiratory support regarding WBSS, KRS and GRSS score and hospital stay

	Cases need Respiratory support (n=15)	Cases not needed respiratory support (n=25)	P value
WBSS score Mean ±SD Median (IQR)	9.5±1.4 9(9-10)	6.9±1.6 7(7-8)	<0.001*
KRS score Mean ±SD Median (IQR)	5.8±1.6 5(5-7)	3.8±0.72 4(4-4)	<0.001*

GRSS score Mean ±SD Median (IQR)	7.2±1.4 8(6-8)	4±1.05 4(3-5)	<0.001*
Hospital stay (Days) Mean ±SD Range	6.2±1.6 (4-9)	4.2±1.3 (3-8)	<0.001*

_* significant at p value <0.05, measured by independent T test.

Table (4): comparison between cases who needed different types of respiratory support regarding WBSS, KRS and GRSS score

	Respiratory support (n=15)			**P value**
	HFNC (n=8)	**CPAP (n=5)**	**MV (n=2)**	
WBSS score Mean ±SD Median (IQR)	8.7±0.8 9(8-9)	9.8±1.09 10(9-10.5)	12±0 12(12-12)	0.02*
KRS score Mean ±SD Median (IQR)	5±0.53 5(5-5)	6.2±1.9 6(4.5-8)	8.5±0.7 8.5(8-9)	0.05*
GRSS score Mean ±SD Median (IQR)	6.2±1.2 6.5(5-7)	8.4±0.54 8(8-9)	8.5±0.7 8.5(8-9)	0.008*

HFNC: High Flow Nasal cannula, CPAP: continuous positive airway pressure, MV: Mechanical ventilation, WBSS: Wang Bronchiolitis Severity Score, KRS: Kristjansson Respiratory Score, GRSS: Global Respiratory Severity Score, * significant at p value <0.05, measured by ANOVA test, *n=number

Table (5): ROC curve analysis for WBSS, KRS and GRSS score for prediction of need for respiratory support

	WBSS score	**KRS score**	**GRSS score**
Cut off value	>8.5	>4.5	>5.5
AUC	0.91	0.908	0.945
95% CI	0.81-0.99	80-0.99	0.87-0.99
P value	<0.001*	<0.001*	<0.001*
Sensitivity	80%	86.7%	87%
Specificity	92%	88%	92%
PPV	85.7%	81.3%	86.7%

NPV	88.5	91.7%	92%
Total accuracy	87.5%	87.5%	90%

_* significant at p value <0.05
PPV=positive predictive value, NPV=negative predictive value, AUC=Area Under the Curve, CI=Confidence Intervals.

Table (6): ROC curve analysis for WBSS, KRS and GRSS score for prediction of need for ICU admission

	WBSS score	**KRS score**	**GRSS score**
Cut off value	>8.5	>4.5	>6.5
AUC	0.86	0.91	0.94
95% CI	0.72-0.99	0.79-0.99	0.83-0.99
P value	0.001*	<0.001*	0.003*
Sensitivity	80%	90%	90%
Specificity	80%	77%	90%
PPV	57.1%	56.3%	75%
NPV	92.3%	95.8%	96.4%
Total accuracy	80%	80%	90%

_* significant at p value <0.05PPV=positive predictive value, NPV=negative predictive value
Table (7): correlation between hospital stay and WBSS, KRS and GRSS score among children who needed NICU admission

	Hospital stay	
	r	P value
WBSS score	0.57	0.04*
KRS score	0.72	0.01*
GRSS score	0.51	0.05*

_* significant at p value <0.05

DISCUSSION

40 infants, ages up to 12 months, who were admitted to Zagazig University Hospital with bronchiolitis were included in the current study. The average gestational age of the infants in our study was 38.27 ± 0.8 weeks, and the average age of the newborns included in our study was 4.52 ± 2.9 months.

According to our study, 13 patients (32.5%) were female and 27 patients (67.5%) were male.The newborns in our study weighed an average of 6.76 ± 1.7 kg.

Similarly, 60 children with bronchiolitis who were brought to a pediatric emergency room participated in a prospective observational research conducted by Pinto et al. [4]. According to Pinto et al. [4], 21 patients (54.5%) were male. Six months (4–10) was the median age.

To determine which of the three clinical ratings most accurately predicts the length of hospital stay and the requirement for respiratory support in neonates and babies hospitalized to neonatal units for bronchiolitis, De Rose et al. [8] carried out a retrospective analysis. At admission, the median age was 24 (16–35 days). The typical gestational age was 39 (38–40) weeks, and the median weight at admission was 3530 (3180–4054) grams.

Similarly, **Sankannavar et al. [9]** 69 toddlers under the age of two who had all been diagnosed with bronchiolitis participated in a prospective observational research. According to **Sankannavar et al. [9],** 46 patients, or 66.67%, were male.

According to our research, the majority of patients (62.5%) had respiratory distress (RD II) when they were admitted. In terms of overall appearance, 35% showed signs of inadequate eating. Eighty percent of the patients had normal skin, twenty percent had pallor, and none had cyanosis.

In terms of muscle retraction, 7.5% experienced severe nasal flaring, 45% intercostal retraction, and 22.5% tracheosternal retraction. 10% wheezed during inspiration, 30% during terminal expiration, and 60% during expiration on auscultation. Furthermore, 72.5% had poor air entrance, 27.5% had good air entry, and 12.5% had lethargy. The average oxygen saturation was 94.05 ± 1.3%, and the average respiratory rate was 57.5 ± 5.71 breaths per minute.

Our investigation revealed that 37 (92.5%) of the patients had aberrant appearances, whereas 3 (7.5%) had normal appearances, according to WBSS. Of them, 1 (2.5%) had a respiratory rate between 30 and 45 breaths per minute, 28 (70%) had a respiratory rate between 46 and 60 breaths per minute, and 11 (27.5%) had a respiratory rate greater than 60 breaths per minute. In terms of muscle retraction, intercostal muscle retraction was present in the majority of individuals. The majority of patients exhibited full expiration or audible expiration without a stethoscope in terms of auscultation. The mean score overall was 7.9 ± 2.A moderate to severe level of respiratory distress is indicated by the observed mean WBSS score of 7.9 ± 2 in babies with bronchiolitis.

The constancy of WBSS as a trustworthy biomarker of respiratory impairment in bronchiolitis is supported by the findings of Sankannavar et al. [9], who reported a median WBSS of 8 (Interquartile Range, IQR = 3).

These findings are significant because they can be used to stratify the severity of bronchiolitis and measure respiratory distress. Increased WBSS scores highlight the need for close observation and maybe more extensive therapies, as seen in this study and the Sankannavar et al. [9] cohort. On the other hand, De Rose et al.'s lower scores can indicate milder instances or early intervention.

These discrepancies highlight how crucial it is to use WBSS as a standardized technique to predict outcomes and aid clinical decision-making in infants with bronchiolitis [10].

Three patients (7.5%) had normal appearance, thirty-one (77.5%) had moderately impacted appearance, and six (15%) had severely affected appearance, according to KRS. Of them, 11 (27.5%) had a respiratory rate greater than 60 breaths per minute, while 29 (72.5%) had a respiratory rate between 40 and 60 breaths per minute. There were eleven (27.5%) individuals with pallor skin and 29 (72.5%) individuals with normal skin color. The majority of individuals experienced considerable muscular retraction in this aspect. In terms of auscultation, five (12.5%) of them had wheezes. Regarding the overall score, the average was 4.6±1.48. The study's mean KRS score of 4.6± 1.48 indicates that infants with bronchiolitis are experiencing a moderate level of respiratory distress.

These results show consistency in the use of

KRS as a measure for evaluating respiratory status and are in close agreement with those of De Rose et al. [8] and Pinto et al. [4], who both reported median KRS scores of 4.0 (IQR: 3.00–5.00) upon admission.

The usefulness of the KRS score in tracking clinical progress was highlighted by Pinto et al. [4], who noted a little increase in the score during the second assessment at admission (median 4.5, IQR: 4–5) and a notable improvement at discharge (median 3.0, IQR: 2–5).

These variances highlight how flexible the KRS is in assessing the range of respiratory distress levels. All things considered, the findings show that KRS is a valid measure for assessing and monitoring respiratory disorders, confirming its importance in directing treatment choices and forecasting bronchiolitis recovery times [8].

In accordance with GRSS, our research revealed that 19 patients (47.5%) had mild appearance, 17 patients (42.5%) had moderate look, and 4 patients (10%) had severe appearance. None of the patients developed cyanosis in terms of skin color. The majority of patients (77.5%) exhibited respiratory muscle retraction. All patients underwent auscultation; six (15%) of them showed signs of lethargy, and 31 (77.5%) showed signs of air entry. The mean O2 saturation was 93.02 ± 6.6 and the mean respiratory rate was 58.5 ± 7.9.

This study's preponderance of mild to moderate cases demonstrates how well the GRSS can stratify the severity of bronchiolitis. Further demonstrating the usefulness of GRSS in capturing the complex appearance of respiratory distress in babies with bronchiolitis, the observed respiratory muscle retraction and moderate oxygen saturation support both early assessment and continued therapy [11].

The study by De Rose et al. [8] revealed that the median GRSS was 4.90 (IQR 3.89–6.10), which is consistent with our findings and reflects comparable patterns of respiratory distress severity in their group.

A small percentage of patients received combined or alternative regimens, such as ceftazidime (2.5%) or cefepime (2.5%), while 5% did not require antibiotics, indicating varying infection profiles among patients. Cefotaxime was the most frequently prescribed antibiotic (40%), followed by ampicillin (32.5%). Ipratropium-corticosteroid nebulizers were used to treat all patients (100%) and intravenous fluid supplementation was used worldwide, highlighting their crucial significance in symptom management and hydration.

With 80% reaching a normal respiratory rate, 62.5% demonstrating normal feeding, and 27.5% exhibiting no wheezes, follow-up data showed significant clinical changes. A lesser percentage showed improvements in feeding, respiratory sounds, and chest clarity. These results demonstrate the efficacy of the used treatment approaches and emphasize the significance of customized interventions to maximize patient outcomes [12].

In line with the mostly viral etiology of bronchiolitis, the mean white blood cell count during the follow-up period was 8.03 ± 2.18, which is within the normal range for children and indicates no substantial leukocytosis or leukopenia. Since lymphocytes usually predominate in viral infections, the greater lymphocyte mean of 5.28 ± 2.62 is consistent with a viral infection, although the neutrophil mean of 2.78 ± 0.48 indicates a modest inflammatory response.

The majority of cases showed low-grade inflammation, which supports the viral character of the disease. The median C-reactive protein (CRP) level during the follow-up was 1.7, with a range of 0.3 to 14.6. The wider range of CRP, however, might indicate variations in inflammatory reactions, possibly as a result of varying illness severity or concurrent bacterial infections in a subgroup of individuals. These results support the necessity of carefully interpreting laboratory results in cases of bronchiolitis, with an emphasis on clinical presentation to direct treatment.

Regarding patient outcomes, 10 patients (25%) suffered respiratory distress (RD III) and needed to be admitted to the intensive care unit (NICU) or PICU, whereas 30 patients (75%) had no issues. In the end, every patient improved, and their average hospital stay was 4.9 ± 1.4 days. The patient outcomes highlight how, with proper management, pediatric patients with bronchiolitis typically have a satisfactory prognosis.

WBSS, KRS, and GRSS scores for patients who needed respiratory support and those who didn't were shown to differ significantly ($p < 0.01$) in our study. those requiring respiratory assistance had significantly higher median scores for WBSS, KRS, and GRSS (9, 5, and 8 respectively) than those not in need of respiratory support (7, 4, and 4). These results highlight the potential usefulness of clinical severity scores in identifying patients at increased risk of respiratory compromise, as they indicate a clear correlation between higher scores and the requirement for breathing support.

Our findings are consistent with a retrospective cohort study by Kubota et al. [6] that had 250 infants under 10 months of age who were all admitted with an RSV infection. According to Kubota et al. [6], there is a strong correlation between the severity of illness and the need for respiratory support. The group that required support had a significantly higher GRSS (median of 4.86, IQR 3.67–6.10) than the group that did not (median of 2.79, IQR 1.91–3.83), with a p-value of <0.001.

Further supporting the link between increased severity and the need for respiratory assistance, Kubota et al. [6] demonstrated that the WBSS was significantly higher in the group requiring respiratory support (median of 8, IQR 7–9) compared to the non-support group (median of 6, IQR 5–7), with a p-value of <0.001.

De Rose et al. [8] found that infants who needed respiratory support were hospitalized earlier, but the difference was not statistically significant (median 23.5 days, IQR 15.0–34.0, compared to median 25.5 days, IQR 18.0–36.0; $p = 0.322$). This finding is consistent with our findings. The two groups' median admission weights were similar, weighing 3,490 grams (IQR 3,135–3,940) and 3,590 grams (IQR 3,320–4,100; $p = 0.288$).

According to our findings, the majority of patients benefited from non-invasive interventions, with respiratory support being needed in 37.5% of cases, high-flow nasal cannula (HFNC) being the most commonly used modality (53.3%), followed by continuous positive airway pressure (CPAP) in 33.3%, and mechanical ventilation (MV) in just 13.3%. The findings draw attention to important facets of the research population's clinical outcomes and illness management.

The study De Rose et al. [8] found that 44.3% (43 cases) required supplemental oxygen at concentrations higher than 21%, and 73.2% (71 cases) required a high-flow nasal cannula (HFNC), which is consistent with our findings. 12.4% (12 patients) required nasal continuous positive airway pressure (nCPAP), and 3.1% (3 cases) required mechanical ventilation.

According to Kubota et al. [6], babies with bronchiolitis who require respiratory support are more likely to require mechanical ventilation, nCPAP, and a high-flow nasal cannula.

Furthermore, we found that patients who needed different kinds of respiratory support had statistically significant differences (p <

0.05) in their WBSS, KRS, and GRSS scores. The increasing severity of disease linked to more intense respiratory interventions was reflected in the median scores, which were lowest among patients on HFNC and highest among those who needed mechanical ventilation, followed by those on CPAP.

Similarly, De Rose et al. [8] showed that in patients with high-flow nasal cannulas, WBSS, KRS, and GRSS scores were substantially linked with maximal flow rates (r-values of 0.229 (p = 0.009) for WBSS, 0.155 (p = 0.034) for KRS, and 0.277 (p = 0.005) for GRSS). Furthermore, WBSS and KRS scores were significantly higher (p < 0.001) for infants who needed CPAP. The median WBSS, KRS, and GRSS scores for patients in need of mechanical ventilation were 6.00, 7.00, and 7.38, respectively. This indicates that higher scores are linked to more serious respiratory support requirements.

WBSS, KRS, and GRSS scores demonstrated good predictive capacities for identifying the requirement for respiratory support, according to our study. WBSS's ROC curve study revealed a cutoff value of more than 8.5, resulting in an overall accuracy of 87.5%, a sensitivity of 80% and a specificity of 92%, a PPV of 85.7% and NPV of 88.5%, and an area under the curve (AUC) of 0.91. These findings, which are backed by a substantial p-value (<0.05), show that WBSS is dependable in detecting patients who need breathing support while maintaining a high level of sensitivity and specificity.

Our results are consistent with a research by De Rose et al. [8] that showed excellent sensitivity for WBSS (85.71%), highlighting its efficacy in identifying the majority of patients who need intervention. Our results are supported by the De Rose et al. [8] study's strong positive predictive value (PPV) (92.3%) and moderate specificity (80.77%), which indicate that WBSS is a trustworthy method for determining if respiratory support is required. They may have under-identified certain cases, though, as evidenced by their lower negative predictive value (NPV) of 67.7%, which shows a restriction in excluding patients who could need assistance. Given that our better specificity means fewer false positives when forecasting support needs, this somewhat supports our findings.

Comparatively speaking to our results, Sankannavar et al. [9] reported perfect sensitivity (100%), guaranteeing that no true positives were overlooked, but poorer specificity (52.38%), reflecting a greater percentage of false positives. Although our analysis provides a more balanced predictive profile, their WBSS PPV of 82.76% and NPV of 100% indicate that it performs better in confirming negative instances than the findings of De Rose et al. [8]. Our findings that a cutoff of 8.5 is very effective in clinical decision-making are further supported by the Sankannavar et al. [9] study, which had an overall accuracy of 85.51%, which is just lower than ours (87.5%).

With a threshold value of >4.5, our study showed that the KRS was a valid instrument for predicting the need for respiratory support. Its sensitivity and specificity were 86.7% and 88%, respectively, with a PPV of 81.3% and NPV of 91.7%. With a significant p-value (<0.05), an AUC of 0.908, and a total accuracy of 87.5%, KRS exhibits good predictive ability. These results highlight the effectiveness of KRS in detecting individuals who are susceptible to respiratory decline while striking a balance between sensitivity and specificity.

According to the study by De Rose et al. [8], KRS demonstrated moderate sensitivity (75.71%), showing its capacity to detect a respectable percentage of true positives, which is consistent with our findings. In line with our findings, the high specificity (92.31%) indicates that KRS successfully reduces false positives. Their 96.4% PPV confirms our study's finding that the majority of positive predictions were correct. The findings of De Rose et al. [8] indicate a limitation in ruling out cases, nevertheless, with a lower NPV of 58.5%, which may indicate an underestimating of false negatives. This is somewhat consistent with our findings because fewer cases are overlooked due to our increased sensitivity.

Comparing KRS to our study, Sankannavar et al. [9] discovered that while KRS had perfect sensitivity (100%), guaranteeing that no true positives were missed, its specificity was lower at 66.67%, suggesting a larger probability of false positives. Their 87.27% PPV closely matches our results, demonstrating how effective KRS is at confirming positive cases. Additionally, their NPV of 100%, which is somewhat better than the performance shown in the De Rose et al. [8] study, indicates perfect dependability in ruling out patients without the requirement for breathing support. The overall accuracy of 89.86% reported by Sankannavar et al. [9] is similar to our findings, confirming KRS's potency as a predictor.

Our research showed that the GRSS was a very good predictor of the requirement for respiratory support, with a cutoff value >5.5 resulting in 87% sensitivity and 92% specificity, 86.7% PPV, and 92% NPV. The total accuracy was 90%, with a significant p-value (<0.05) supporting the outstanding discriminatory ability indicated by the area under the curve (AUC) of 0.94. These findings demonstrate that the GRSS is a strong and trustworthy method for determining whether patients are at danger of respiratory compromise.

Our results are supported by a research by De Rose et al. [8] that found the GRSS performed better than other scoring systems, with a sensitivity of 93.75%, demonstrating its great capacity to identify the majority of true positives. Its 88.24% specificity, which closely matches the specificity found in our investigation, demonstrates its dependability in reducing false positives. Its remarkable 96.8% positive predictive value (PPV) and 78.9% negative predictive value (NPV) further support its usefulness in making correct predictions. Its superior capacity to detect genuine negatives is highlighted by its higher NPV when compared to other scores.

In line with our findings, De Rose et al. [8] verified that GRSS was the most successful scoring system out of the three they examined, with a post-test probability of 87%.

In a similar vein, Kubota et al. [6] found an AUC of 0.875 for GRSS, which is marginally lower than the AUC of 0.94 in our analysis but still indicates good predictive accuracy. Their determined ideal cutoff value of 4.52 produced a 90% specificity, which is similar to our results. Both studies confirm that the GRSS is a reliable indicator of respiratory support needs, however the discrepancies in cutoff values and AUC can be due to differences in sample sizes, population characteristics, or clinical procedures.

Overall, the studies' agreement highlights the therapeutic usefulness and dependability of GRSS in determining the need for respiratory support. Its exceptional sensitivity, specificity, and accuracy make it an invaluable instrument for directing prompt therapies, especially when it comes to identifying babies with bronchiolitis who are at high risk while retaining a high degree of discriminatory power [8].

According to our research, individuals who needed respiratory support had a considerably longer hospital stay than those who didn't ($p < 0.01$). Patients who required respiratory support spent an average of 6.2 days in the hospital, whereas those who did not required respiratory support spent 4.2 days.

However, compared to infants who were more critically ill (median 6.0 days, IQR 5.0–8.0; p < 0.001), those who did not require respiratory assistance had a considerably shorter hospital stay (median 3.0 days, IQR 1.0–4.0).

The findings' agreement emphasizes the clinical utility of WBSS, KRS, and GRSS as instruments for determining the severity of a condition and predicting the demand for hospital resources. The overall consistency supports the usefulness of these grading systems in pediatric critical care, even when differences in correlation strength may be due to differences in study populations, clinical procedures, or severity distributions.

A statistically significant (p < 0.05) association was seen between hospital stay and the WBSS, KRS, and GRSS scores. Higher scores are linked to longer hospital admissions, according to the moderately positive correlations found for KRS (r = 0.52) and GRSS (r = 0.53) and the mildly positive connection found for WBSS (r = 0.45). These results highlight the usefulness of these scores in predicting both the length of hospital stay and ICU admission.

Based on ROC curve analysis, our study discovered that WBSS, KRS, and GRSS were successful in forecasting the requirement for ICU admission.

In the current study, an AUC of 0.86, an accuracy of 80% (p < 0.05), and a sensitivity and specificity of 80% were obtained for WBSS with a cutoff value larger than 8.5. At a cutoff value larger than 4.5, KRS demonstrated a higher sensitivity (90%) and specificity (97%) with an accuracy of 80% (p < 0.05) and an AUC of 0.91. With an AUC of 0.94 (p < 0.05), GRSS showed the best accuracy (90%) with a sensitivity and specificity of 90% at a cutoff of larger than 6.5. These findings demonstrate the great predictive power of these ratings, with GRSS demonstrating the highest accuracy.

Sankannavar et al. [9] found a substantial correlation between hospital stay duration and both WBSS and KRS (r = 0.6818 for WBSS and r = 0.6622 for KRS, p < 0.001), which is in line with our findings. With AUCs of 0.96 for WBSS and 0.99 for KRS, they also discovered that both scores rose in proportion to the severity of bronchiolitis, suggesting that severity assessment had good discriminatory power.

Among children who needed NICU admission, our study showed a statistically significant connection (p < 0.05) between hospital stay and WBSS, KRS, and GRSS scores. WBSS and hospital stay showed a moderately favorable connection (r = 0.57), suggesting that longer hospital stays are linked to higher WBSS scores. Likewise, moderate associations between hospital stay and GRSS (r = 0.51) and KRS (r = 0.72) were found, indicating that higher scores in these measures indicate longer hospital stays. These results demonstrate the potential value of these scoring systems in predicting hospital length of stay and resource use in critically unwell children.

The study by De Rose et al. [8] likewise found substantial connections between the three scores and hospital duration of stay, which is consistent with our findings. The WBSS showed a r2 of 0.139 (p < 0.001), meaning that it may account for around 14% of the variation in hospital stays.

Their correlation with length of stay was further supported by the KRS's r2 of 0.137 (p < 0.001) and the GRSS's r2 of 0.170 (p < 0.001). The predictive relevance of these scores is highlighted by the consistent significance throughout both studies, even if the correlation coefficients in De Rose et al.'s study show a somewhat weaker link than ours [8].

Pinto et al. [4] emphasized the accuracy of KRS in predicting disease severity, which is consistent with these findings. Along with comparable results for WBSS, they showed good inter-rater reliability for KRS (ICC = 0.78) and a moderate connection with SpO_2 values at admission and discharge. The validity and usefulness of these grading systems in clinical practice for determining the severity of bronchiolitis and forecasting ICU admission and hospital outcomes are reaffirmed by the consistency of these research. The general agreement reinforces the clinical significance of these instruments, even when differences in cutoff values and correlations may result from differences in study populations and techniques.

Conclusion:

With higher scores highly correlated with the requirement for respiratory interventions and longer hospital stays, our results show that these ratings accurately identify patients at increased risk for respiratory compromise. Interestingly, the GRSS had the best predictive accuracy for both ICU admission and respiratory assistance. The study also highlights how well non-invasive respiratory support—like a high-flow nasal cannula—works to manage most instances.

Conflict of Interest: None

Financial Disclosures: None

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Table (1Supplementary): Distribution of Wang Bronchiolitis Severity Score (WBSS) in the studied patients.

	Studied patients (N=40)	
	N	**%**
General appearance		

	Studied patients (N=40)	
	N	**%**
Normal: (0)	**3**	**7.5%**
Abnormal: (3)	**37**	**92.5%**
Respiratory rate (breaths/min)		
30–45: (1)	**1**	**2.5%**
46–60: (2)	**28**	**70%**
>60: (3)	**11**	**27.5%**
O_2 saturation	**NA**	**NA**
Skin color	**NA**	**NA**
Respiratory muscle retraction		
None: (0)	**9**	**22.5%**
Intercostal: (1)	**19**	**47.5%**
Tracheosternal: (2)	**9**	**22.5%**
Severe with nasal flaring: (3)	**3**	**7.5%**
Auscultation		
Terminal expiration or only with stethoscope: (1)	**14**	**35%**
Entire expiration or audible on expiration without stethoscope: (2)	**22**	**55%**
Inspiration and expiration, without a stethoscope: (3)	**4**	**10%**
Lethargy	**NA**	**NA**
Air entry	**NA**	**NA**
	Mean	**±SD**
Total score	**7.9**	**2**

Table (2Supplementary): Distribution of Kristjansson respiratory score (KRS) in the studied patients.

	Studied patients (N=40)	
	N	**%**
General appearance		
Normal (o)	**3**	**7.5%**
Moderately affected (1)	**31**	**77.5%**
Severely affected (2)	**6**	**15%**

	Studied patients (N=40)	
	N	%
Respiratory rate		
40-60 (1)	**29**	**72.5%**
>60 (2)	**11**	**27.5%**
O_2 saturation (%)	**NA**	**NA**
Skin color		
Normal (0)	**29**	**72.5%**
Pallor (1)	**11**	**27.5%**
Respiratory muscle retraction		
None (0)	**9**	**22.5%**
Moderate costodiaphragmatic (1)	**28**	**70%**
Severe (as in 1 plus rib and jugular) (2)	**3**	**7.5%**
Auscultation		
None (1)	**35**	**87.5%**
Wheezes (2)	**5**	**12.5%**
Lethargy	**NA**	**NA**
Air entry	**NA**	**NA**
	Mean	**±SD**
total score	**4.6**	**1.48**

SD: Standard Deviation

Table (3Supplementary): Distribution of Respiratory Severity Score (GRSS) in the studied patients.

	Studied patients (N=40)	
	N	%
General appearance		
Mild	**19**	**47.5%**
Moderate	**17**	**42.5%**
Sever	**4**	**10%**
skin color		
No cyanosis	**40**	**100%**
Respiratory muscle retraction		
Yes	**31**	**77.5%**
No	**9**	**22.5%**
Auscultation	**40**	**100%**
Lethargy		
Yes	**6**	**15%**

	Studied patients (N=40)	
	N	**%**
No	**34**	**85%**
Air entery		
Yes	**31**	**77.5%**
No	**9**	**22.5%**
	Mean	**±SD**
Respiratory rate(breath/min)	**58.5**	**7.9**
O2 saturation(%)	**93.02**	**6.6**

SD: Standard Deviation

Table (4Supplementary): Distribution of treatment in the studied patients.

	Studied patients (N=40)	
	N	**%**
Respiratory support		
No	25	62.5%
Yes	15	37.5%
Type of respiratory support (n=15)		
HFNC	8	53.3%
CPAP	5	33.3%
MV	2	13.3%
Antibiotics		
No	2	5%
Cefotaxim	16	40%
Ampicillin	13	32.5%
cefotaxim and ampicillin	1	2.5%
Ceftazidime	1	2.5%
Cefepime	1	2.5%
Nebulizers		
Ipratropium – corticosteroid	40	100%
Need of IV fluid	40	100%

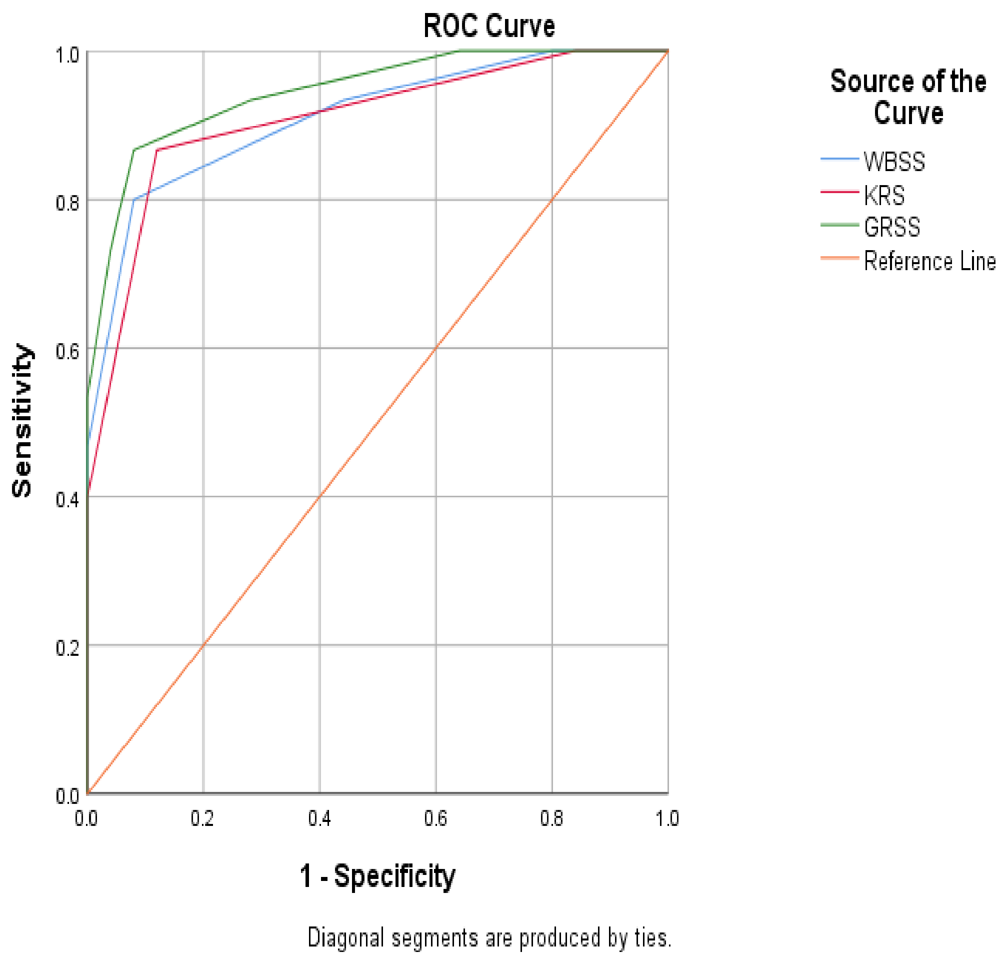

Fig (1Supplementary): ROC curve analysis for WBSS, KRS and GRSS score for prediction of need for respiratory support.

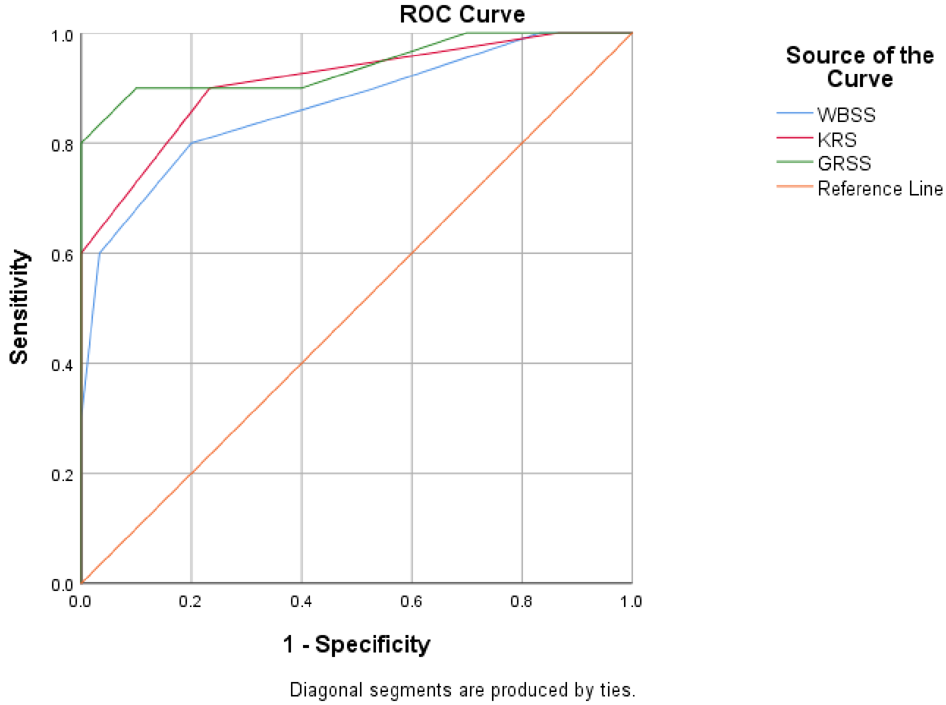

Fig (2 Supplementary): ROC curve analysis for WBSS, KRS and GRSS score for prediction of need for ICU admission

Citation

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