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Respiratory severity score and pediatric respiratory severity score criteria in grading and management of pediatric acute respiratory illness

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Abstract
Background and Purpose: Acute respiratory tract infections (ARI) are the leading cause of death in children in the world with the greatest number of deaths occurring in developing countries like India. Considering the prevalence of ARI the use of an objective measure of severity of respiratory illness would have implications in clinical management as well as clinical research. So we compared respiratory severity scoring system RSS (Respiratory Severity Score) with PRESS (Pediatric Respiratory Severity Score), so that we can find out which of the above scores are better and whether they can be implemented to assess pediatric ARI patients.
Method: This prospective observational study was conducted in Pediatrics wards, Shri Vasantrao Naik Government Medical College, Yavatmal, Maharashtra India and data was collected from 290 children below 12 years of age by purposive sampling. All the children presenting with respiratory symptoms were subjected to these scoring system (RSS AND PRESS) at the time of admission and were classified based on the scores obtained in respective scoring system. Data was analysed using frequencies, percentages and contingency tables and comparison was made between the above scoring systems to find which one is better applicable in pediatric ARI patient.
Results: Incidence of pediatric patients presenting with only respiratory tract infections who are admitted in ward was 25.15 %, with more incidence being reported in children below 12 months (49.31%), males more affected. For both the ARI scoring systems (RSS and PRESS) as the severity increased so is the number of patients requiring oxygen and duration of hospitalization increased significantly (p<0.05) suggesting positive correlation, with RSS having stronger association.
Conclusion: Both the scoring systems predicted that on admission if the score is more than chances of requirement of oxygen is more and also duration of hospitalization is more, with RSS being better predictor.

Keywords: ARI, Pediatric, RSS, PRESS, Grading

Introduction
Acute respiratory tract infections (ARI) are the leading cause of death in children in the world (11.9 million per year) with the greatest number of deaths occurring in developing countries [1]. Although implementation of safe, effective and affordable intervention has reduced mortality from ARI but still it account for one fifth deaths [2, 3] in developing countries of the total deaths due to ARI in India, approximately one fourth (2.5 million) are in children less than five years of age4.Considering the prevalence of ARI the use of an objective measure of severity of respiratory illness would have implications in clinical management as well as clinical research. There has been many severity scores that have been developed for various purposes, such as development of WHO grading of respiratory illness [5, 6] RISC (Respiratory Index of Severity in Children) score among young children with respiratory infections in South Africa [7]. Moreover it is crucial to treat acute respiratory infections appropriately to avoid risk of respiratory failure, which is fatal in children. Severe cases must be triaged and treated immediately, therefore it is important to assess respiratory condition at first contact. Hence these scores may help to assess and classify respiratory illness. Most recently Million death study collaborators has found estimate of LRI associated mortality in India, in which pneumonia was held responsible for 369,000 deaths (28 % of all deaths) below 5 years, making it the single most important cause of death in this age group [8].

Acute respiratory tract infections (ARI) are being increasingly recognized as a major cause of childhood mortality, being a third of all under five deaths in developing countries. The single largest contributor of childhood morbidity and mortality is acute respiratory tract infection with estimated 3–5 episodes every year, with nearly [24] million cases of pneumonias, and 1 million deaths [9, 10, 11]. Amongst all the children attending the pediatric OPD 30–50% of patients and almost 20–40% of hospital admissions may be due to ARI and pneumonia [12].

The majority of scores are applied to hospitalized children where many healthcare resources and broader testing may be available and also there are large number of children with respiratory tract infection in resource limited country like India, whether to subject children for the treatment or other investigation is a problem. To address this issue, we want to compare respiratory severity scoring system like RSS (Respiratory Severity Score) [13] and PRESS (Pediatric Respiratory Severity Score) [14], so that we can find out which of the above two scores are better and whether they can be implemented to assess pediatric RI patients.

Aims and Objectives

To find out the incidence of ARI, classify and applicability of scoring systems namely RSS and PRESS in hospitalized children less than 12 years of age. To find out which score is better predictor of severity in ARI based on oxygen requirement and duration of hospital stay.

Materials and Methods

Study was approved by institutional ethics committee. All Children between the age of one day to twelve years of age admitted in Pediatric ward with respiratory symptoms were included in the study after applying inclusion and exclusion criteria with written informed consent in our hospital during the term between 1st may 2017 to 31st January 2018.This is hospital based observational prospective study with purposive sampling.

Inclusion Criteria-Children between the age group one day to twelve years of age presenting with respiratory symptoms were included in study.

Exclusion Criteria-Children who were hemodynamically unstable or suffering from chronic respiratory tract illness (e. g. Asthma, Emphysema, Chronic bronchitis etc.) or having concurrent other organ system disease.

Method of study-A total of 290 patients were enrolled in study. A detailed history and physical examination was done at the time of admission. All the included pediatric patients were subjected to these scoring system (RSS AND PRESS) at the time of admission.

Total score was arrived at by addition of scores for individual clinical signs and were classified based on the scores obtained in respective scoring system into the severity group as discussed below, then these findings were entered on specially designed proforma.

Scoring systems and their method of application.

RSS (Respiratory Severity Score) [3]

Table 1: Four parameters measured in RSS which are as follows

Score	Respiratory rate	Wheeze	Spo2 at room air	Accessory respiratory muscle utilization
0	<30	None	>95	None
1	31-45	End expiratory only audible by stethoscope	90-94	Mild intercostal in drawing
1.5		Not otherwise specified		Not otherwise specified
2	46-60	Entire expiration and inspiration with stethoscope only	85-89	Moderate amount of intercostal in drawing

Lower value for LRTI in their study was 4 so score equal to or above this is taken as severe and less than or equal to 3 is taken as mild.

PRESS (Pediatric Respiratory Severity Score) [14]

In this five parameters were measured which are as follows

Scoring

1. Respiratory rate at rest on room air 0 or 1 Criteria of tachypnea

Month			Respiratory rate	
<2			>60	1
≥ 2	-	<12	>50	1
≥12	-	<35	>40	1
≥36	-	<156	>30	1
≥156			>20	1

*Respiratory rate evaluated according to American Heart Association guidelines.

2. Wheezing- High pitched expiratory sound heard by auscultation 1

3. Accessory muscle use-Any visible use of accessory Muscle 1

4. Spo2-Oxygen saturation <95% at room air 1

5. Feeding difficulty -Refusing feedings 1

Based on total score ARI is classified as: mild-(0-1), moderate-(2-3), Severe-(4-5) after addition of individual clinical feature score to arrive at final score, these included children were followed up in the ward for following parameters.

1. Need for oxygen therapy

2. Duration of hospital stay: In each severity group. The data thus obtained was compared in between these scoring systems and efforts are made to find out which of the two scoring systems is better applicable in pediatric ARI patient.

Statistical methods to be used: Descriptive statistics, frequencies and percentages, contingency tables using Microsoft excel 10 was used. -Chi-square test and ANOVA test with significance level kept at 0.05 were used for oxygen requirement and duration of hospitalization respectively in both scoring systems.

For comparison of the two scoring systems (RSS and PRESS) to see which one is better predictor with respect to

oxygen requirement as outcome Binary Logistic Regression (BLR) test was used and for duration of hospitalization as outcome Multiple Linear Regression (MLR) test was used

Investigations: Determination of SPO2 was done by portable pulse oximeter (Nellcore Traze Duo Max), which works on the principle of differential absorption of infrared and red light by oxygenated and deoxygenated hemoglobin. Site of application in Pediatric patients was fingers while in infants site was foot.

Follow UP: Yes

The patients who were enrolled in this study were followed up during there entire period of hospitalization for oxygen requirement and duration of hospitalization.

Results

In this study 290 patients were selected during the study period out of total 1153 patients admitted in ward, giving incidence of 25.15%.

Table 2: Age and Gender wise distribution of patients

N=290	Infant < 12 months	Toddler >12 to <36 months	Preschool >36 to <72 months	Grade School >72 to <144 months	Total
Male	83	60	15	19	177
Female	60	37	09	07	113
Total	143(49.31%)	97 (33.44 %)	24 (8.27 %)	26 (8.96%)	
Ratio(M:F)	1.38:1	1.62:1	1.66:1	2.7:1	1.56:1

Majority of patients of ARI in the present study were less than 3 years of age 82.75 %, with 49.31 % of them being infant.. Male preponderance was present with male to female ratio being 1.56:1. (Table 2).

Table 3: Clinical features according to scoring system:-

	Total number of patients-290
Characteristic	Number of Patients
Increased respiratory rate	198 (68.28%)
Wheezing	194 (66.89%)
Accessory muscle use	162 (55.86 %)
Feeding difficulty	91 (31.37 %)
SPO2<95 % at room air	43 (14.82%)

Most common clinical feature was increased respiratory rate (68.28%) followed by wheeze while least common was SPO2<95 % at room air (14.82%). (Table 3)

Table 4: Distribution according to RSS and PRESS system

Total=290	RSS		PRESS		
	Mild- 132(45.51%)	Severe-158 (54.48 %)	Mild-88 (30.34%)	Moderate-154 (53.10 %)	Severe-48 (16.55 %)
Infant	51	92	32	81	30
Toddler	45	52	29	52	16
Preschool	15	9	10	12	2
Grade school	21	5	17	9	0
M: F	87/45	90/68	61/27	88/66	28/20
Wheeze	49 (37.12%)	145 (91.77%)	24 (27.27%)	126 (81.81%)	44 (91.66%)
Accessory muscle use	29 (21.96%)	133 (84.17%)	8 (9.09%)	106 (68.83%)	48 (100 %)
SPO2<95 % at room air	0 (0%)	43 (27.21%)	0	2 (1.29%)	41 (85.41%)
Increased respiratory rate			11 (12.5%)	139 (90.25%)	48 (100%)
Feeding Difficulty			10(11.36%)	33 (21.42%)	48 (100%)
Oxygen requirement (No. of Cases)	2 (1.51%)	64 (40.5%)	2 (2.27%)	16 (10.38%)	48 (100%)

RSS -Patient characteristic and outcome

After application of RSS more number of patients were in severe group 158 out of 290 (54.5 %) than the mild group 132 out of 290 (45.5%),with percentage of patients having wheeze increased significantly from mild to severe group(from 37.12% to 91.77%). Accessory muscle utilization in mild cases was 21.96 % (29/132) while in severe cases was 83.17 % (133/158). None of the patients in mild group had SPO2 of <95 % at room air while 27.21 % 43/158) patients in severe cases had SPO2 of <95 %.(Table 4) Oxygen requirement in mild group was 1.51% and severe group was 40.5%,chi-square test for oxygen requirement gave p value = 0.00,which was statistically significant. Duration of hospitalization in mild and severe group was 4.59±1.462 and 7.11±2.636 days respectively, on application of ANOVA test p value obtained was 0.00, showing statistically significant correlation.(Table 4)

PRESS-Patient characteristics and outcome

Majority of patients were in moderate group 53.10 %(154/290), followed by mild group 30.34 % (88/290) and least in severe group16.55% (48/290).Tachypnea was present in 12.5 % (11/88) of cases in mild group,90.25 %(139/154) of cases in moderate group,100% (48/48) in severe group. Wheezing increased from 27.27 % (24/88) in mild case to 81.81 % (126/154) in moderate cases to 91.66 % (44/48) in severe cases. Accessory muscle use was seen in 100% (48/48) in severe group of PRESS, was followed

by moderate group (68%) and least in mild group (9.09%) None of the patient in mild group had SPO2 < 95% at room air, while 1.2 %(2/88) in moderate group had SPO2 <95 % and 85.41% (41/44) in severe cases had SPO2< 95%.Severe group showed more feeding difficulty (100%) followed by moderate cases (21.42 %) and least in mild (11.36%).(Table 4) Percentage of patients requiring oxygen in mild, moderate and severe group was 2.27 %,10.38% and 100 % respectively. Chi-square test for the oxygen requirement yielded p value=0.00 suggesting statistically significant correlation There is increase in duration of stay with the increase in severity from mild (4.28±1.295) to moderate (5.66±1.457) to severe (10.02±2.539) group. ANOVA test yielded p value as 0.00 suggesting statistically significant correlation. (Table 4) Comparison of ARI Severity Scoring systems. On application of Binary Logistic Regression (BLR) test for finding out which severity scoring system is better predictor of oxygen requirement we got the Exp (B) as 0.224 for RSS and 0.009 for PRESS. (Table 5).

Table 5: Binary Logistic Regression (BLR) Test for Oxygen requirement

		B	**S.E.**	**Exp(B)**	
Step 1a	RSS	-1.496	0.769		0.224
	PRESS	-4.767	0.765		0.009
	Constant	14.138	2.039	1380000	
a. Variable(s) entered on step 1: RSS, PRESS.					
Multiple linear regression (MLR) data for Duration of hospital stay					
		Unstandardized Coefficients		Standardized Coefficients	
Model		B	Std. Error	Beta	
1	(Constant)	1.027	0.355		
	RSS	0.083	0.297	0.017	
	PRESS	2.581	0.22	0.69	
a. Dependent Variable: Hospital stay					
Pearson Correlation for RSS and PRESS					
		Correlations			
		Hospi stay	RSS	PRESS	
Pearson Correlation	Hospi stay	1	0.766	0.737	
	RSS	0.766	1	0.919	
	PRESS	0.737	0.919	1	

By applying Multiple linear regression (MLR) test with dependent variable as duration of hospital stay and independent variable as RSS and PRESS, result shows that B value for RSS 0.083 and for PRESS 2.581, suggesting PRESS to be better predictor, but due to the suppressor effect of RSS we look at the pearson correlation between them, 0 which shows that r value for duration of hospital stay for RSS is 0.766 and for PRESS r value is 0.737.(Table 5)

Discussion

In the present study the incidence was 25.15 % which lies in the range given by IMNCI 2003 12 Among the total 290 patients 177 were male (61.03%) and 113 were female (38.96%) (Giving male to female ratio of 1.56:1). This finding is similar to the finding of Amy S Feldman *et al*. [13], Yumiko Miyaji *et al*. [14] and McCallum G.B. *et al*. [15] which also had more male patient than female patient. Incidence of ARI was also higher in younger age group (82.75 % of ARI in children <3 years of age) and in males (male to female ratio being 1.56:1) finding similar to "Health indicators in National Health Profile ",2009 Govt. of India [9].(Table 2) Studies have described previous scoring systems for pediatric respiratory infections namely, Gorelick MH *et al*. 2004 [16], Chalut DS *et al*. 2000 [17], Arnold DH *et al*. 2011 [18], Reed C *et al*. 2012 [7], Fujitsuka A *et al*. 2011 [19] and clarified that respiratory rate, wheezing, retraction, and SpO2 are all useful criteria for the assessment of respiratory status and as these parameters are also part of the severity scoring system being studied here so this will also lead to better classification and treatment decision.

In the present study efforts have been made to validate and compare two respiratory severity scoring system namely RSS (Respiratory Severity Score) and PRESS (Pediatric Respiratory Severity Score) over the entire spectrum of acute respiratory illnesses and in the Indian context which makes this study unique. Simultaneous comparison of above two mentioned respiratory severity scores were made to see which scoring system predicted well the outcome in terms of oxygen requirement and duration of hospitalization.

RSS relation with Oxygen requirement and duration of hospitalization. From results it is evident that as the severity group increased from mild to severe so is the percentage of patients requiring oxygen and duration of hospitalization increased with statistically significant relationship (p value < 0.05). (Table 4).As RSS is derived from Modified TAL20, according to Amy S. Feldman *et al*. [13], thus RSS system must also be able to grade the severity of ARI on the basis of oxygen requirement and duration of hospitalization as is the outcome with this study, finding similar to Inbal Golan-Tripto *et al*. [21] who showed that first score at admission is fair predictor of oxygen requirement at 48 hours and length of stay in hospital at 72 hours by Modified TAL criteria.

PRESS relation with Oxygen requirement and duration of hospitalization. It is evident from Table 4 that as the severity score increased from mild to moderate to severe so is the percentage of patients requiring oxygen and duration of hospitalization increased, which was statistically significant (*p* value <0.05).This finding is similar to Yumiko Miyaji *et al*. [14] which also had increased duration of hospitalization and increased oxygen requirement as the severity group increased. Analysis of RSS and PRESS scoring system to see which one among them is better predictor of oxygen requirement and duration of hospital stay.

BLR test was applied to test which scoring system is better predictor of oxygen requirement which gave Exp (B) for RSS as 0.224 and 0.009 for PRESS, as greater is the value

of Exp (B) greater is the association, suggesting RSS being better predictor of oxygen requirement then PRESS. (Table 5) In each of the two scoring systems there is statistically significant increase in duration of hospitalization with the increase in severity score. To make out which severity scoring system is better predictor, MLR Test was used with dependent variable as duration of hospital stay and independent variable as RSS and PRESS, result shows that per unit change in RSS will change the duration of hospital stay by 0.083 days and for PRESS 2.581 days. This shows that PRESS is better predictor. But due to the suppressor effect of RSS we look at the pearson correlation between them, which shows that, r value for duration of hospital stay for RSS is 0.766 and for PRESS is 0.737.This indicates that RSS is better predictor. (Table 5)

Conclusion

-Hence to conclude ARI's constituted 25.15% of the total patient who were hospitalized. On comparing scoring systems of ARI (RSS and PRESS), both the scoring systems predicted that on admission if the score is more then chances of requirement of oxygen is more and also duration of hospitalization is more. Among the two scoring systems RSS is better predictor of oxygen and duration of hospitalization than PRESS in present study.

Recommendation-Thus these clinical scoring system may be useful and applicable in hospital and pre-hospital settings for triage and assessment of respiratory status by medical staff at the initial bedside examination.

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