Clinico-demographic Profile and Predictors of Intensive Care Need in Children with Respiratory Syncytial Virus-associated Acute Lower Respiratory Illness during Its Recent Outbreak alongside Ongoing COVID-19 Pandemic: An Eastern Indian Perspective

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Abstract

Introduction: The objective was to delineate the clinico–epidemiological characteristics of hospitalized children with respiratory syncytial virus (RSV)-associated acute lower respiratory tract infection (RSV-ALRI) during its recent outbreak and to find out the independent predictors of pediatric intensive care unit (PICU) admission.

Materials and methods: Children aged between 1 month and 12 years who tested positive for RSV were included. Multivariate analysis was performed to identify the independent predictors and predictive scores were developed from the β-coefficients. Receiver operating characteristic curve (ROC) was generated and the area under the curve (AUC) was calculated to assess the overall precision. The performance of sum scores in predicting PICU need, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and positive and negative likelihood ratios (LR^+ and LR^-) were calculated for each cutoff value.

Results: The proportion of RSV positivity was 72.58%. A total of 127 children were included with a median [interquartile range (IQR)] age of 6 (2–12) months, of whom 61.42% were males and 33.07% had underlying comorbidity. Tachypnea, cough, rhinorrhea, and fever were predominant clinical presentations while hypoxia and extrapulmonary manifestations were present in 30.71% and 14.96% of children, respectively. About 30% required PICU admission, and 24.41% developed complications. Premature birth, age below 1 year, presence of underlying CHD, and hypoxia were independent predictors. The AUC [95% confidence interval (CI)] was 0.869 (0.843–0.935). Sum score below 4 had 97.3% sensitivity and 97.1% NPV whereas sum score above 6 had 98.9% specificity, 89.7% PPV, 81.3% NPV, 46.2 LR^+, and 0.83 LR^- to predict PICU needs.

Conclusion: Awareness of these independent predictors and application of the novel scoring system will be beneficial for busy clinicians in planning the level of care needed, thereby optimizing PICU resource utilization.

Keywords: Children, Coronavirus disease-2019, Eastern India, Pediatric intensive care unit, Predictors, Respiratory syncytial virus.

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Highlights

With the advent of the coronavirus disease-2019 (COVID-19) pandemic, the epidemiology of RSV is constantly changing. This study found a higher need for pediatric intensive care unit (PICU) admission among children with RSV-ALRI during its recent outbreak. Prematurity, age below 1 year, underlying congenital heart disease (CHD), and hypoxia on admission were the independent predictors of PICU admission. A novel scoring system developed by this study will be beneficial for busy clinicians in planning the level of care needed, thereby optimizing PICU resource utilization.

Introduction

Respiratory syncytial virus is the most prevalent viral cause of acute lower respiratory tract infection (ALRI) and hospitalization in under-five children worldwide and leads to significant mortality, predominantly in the developing world.[1] However, the clinical course of RSV infection varies from asymptomatic exposures to severe lower respiratory tract illness leading to emergency visits, PICU admission, and even mortality. Literature on clinical characteristics, demographic profiles, intensive care needs, and outcomes of hospitalized children with RSV infection from India

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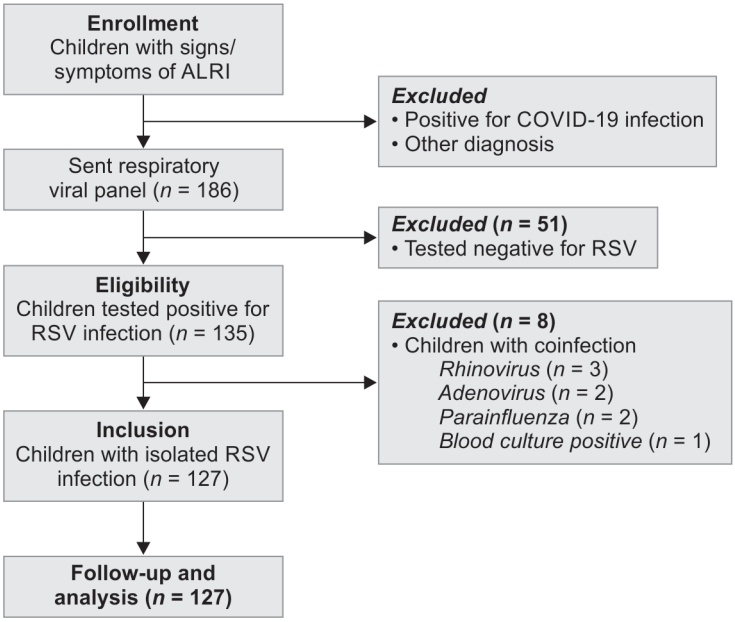
Flowchart 1: Flow diagram detailing study design



is limited. Moreover, with the advent of the COVID-19 pandemic, the epidemiology of RSV is constantly changing. Although reports from around the world at the initial phase of this pandemic have revealed a significant reduction in RSV-related hospitalization,[2,3] many countries also experienced a delayed and much higher than the expected peak in younger infants later on.[4,5] Different Indian print media and electronic media have highlighted the increased incidence of RSV-related hospitalization in recent days and its severe outcome in children, while there is a scarcity of scientific reports from eastern India on such an important child health issue to date. Our study aims to delineate the current clinico–epidemiological characteristics in hospitalized children with RSV-ALRI and to find out the independent predictors of disease severity requiring PICU admission. It will help the public health provider with a road map to design strategies and reallocate the available resource to combat the new epidemic in parallel to the ongoing pandemic which has already overburdened the existing health system.

Materials and Methods

Study Design and Study Population

A prospective observational study was conducted at the department of pediatrics of a tertiary care hospital in eastern India between November 2021 and February 2022. Children aged 1 month to 12 years, admitted with symptoms of ALRI as per local government policy[6] and satisfied World Health Organization (WHO) case definition criteria,[7] were enrolled for this study. Detailed clinico–demographic data including room air oxygen saturation (SpO_2) by pulse oximetry on admission were recorded and relevant investigations were performed as per the requirement. Respiratory viral panels were demanded for eligible children[6] within 48 hours of admission after ruling out COVID-19 infection and those who became positive for RSV infection were included in this study after the exclusion of coinfections (Flowchart 1). Pediatric risk of mortality (PRISM-III) scores was calculated within 24 hours of admission and the extent of organ dysfunction was assessed by the pediatric-sequential organ failure assessment (p-SOFA) score.[8,9] Included children were followed up till discharge or demise. During the hospital stay, additional information related to the treatment, complications, need for PICU admission, oxygen supplementation, and vasoactive medications were documented. Currently, this hospital is running two different PICUs for COVID-19 positive and negative patients. Non-COVID-19 PICU is of 12 bedded (including four step-down beds) one and follows the national consensus guidelines as admission criteria.[10] For comparative analysis, participants were divided into two (PICU and non-PICU) groups based on the requirement of PICU admission.

Viral Testing

For viral testing, clinical specimens such as nasopharyngeal/ throat swabs, wash or aspirate, and tracheal aspirate (for intubated patients) were collected by trained health personnel within 48 hours of admission and transported to the viral laboratory using standard techniques. Samples were tested by multiplex real-time polymerase chain reaction analysis.

Statistical Analysis

Data were analyzed by statistical package for the social sciences (SPSS), version 25, and parameters with a $p < 0.05$ were considered statistically significant. Continuous variables are expressed as mean ± standard deviation (SD) or median ± IQR, whichever is appropriate. Categorical variables are presented as numbers (percentages). Univariate analysis was performed to trace out the significant risk factors for PICU requirement and multivariate logistic regression analysis was carried out with the variables found significant in univariate analysis to identify the independent predictors for PICU admission. Adjusted odds ratios (AORs) with their corresponding 95% CIs were used to report the strength of association between dependent and independent variables.

The β-coefficient of each significant predictor in multivariate analysis was transformed into an item score and a sum score was

calculated for each participant. An ROC was generated and the AUC of the sum scores was calculated to assess the overall precision. To express the performance of sum scores in predicting PICU need, sensitivity, specificity, PPV, NPV, and positive and negative likelihood ratios (LR^+ and LR^-) were calculated for each cutoff value.

Ethical Consideration

This study was approved by Institutional Review Board (IRB) and participants were included after obtaining informed consent from parents/guardians. All procedures contributing to this research comply with the relevant national ethical guidelines in human experimentation and the principles of the Helsinki declarations with its' later amendments.

Results

The proportion of RSV positivity among the screened children with ALRI was 72.58% with all being serotype A. A total of 127 children were included with a median IQR age of 6 (2–12) months, having a male preponderance (61.42%). Among them, 21.26% were born prematurely (<37 weeks of gestation), 32.28% had low birth weight (LBW) and 69.29% were below 1 year of age. Forty-two children had significant comorbidity with the majority being CHD (50%), chronic lung diseases (CLD, 21.43%), and neurological/neuromuscular diseases (16.67%). Tachypnea was present in all children, while cough (81.89%), rhinorrhea (73.23%), and fever (71.65%) were other predominant clinical presentations and about 15% of children had extrapulmonary manifestations. On admission, hypoxia (SpO_2 ≤92% in room air) was found in 30.71% of children and 77.95% had abnormalities in the chest radiographs. A majority of patients (80.31%) received oxygen supplementation while 29.92%, 21.26%, and 7.09% required intensive care admission, mechanical ventilation, and vasoactive medications, respectively. About 24.4% of patients developed complications, commonly acute respiratory distress syndrome (ARDS, 38.71%), encephalopathy (29.03%), hypotension (29.03%), myocarditis (19.35%), and two of them succumbed (Table 1).

No significant difference was found in terms of gender, residence, duration of illness, treatment with antibiotics or systemic steroids among the two groups, while the duration of oxygen requirement, PRISM-III scores, p-SOFA score, and length of hospital stay were significantly higher among children who required PICU admission (Table 2). Children born prematurely or had LBW, aged below 1 year, had significant smoke exposure, presence of underlying comorbidity (CHD or CLD), retraction, extrapulmonary manifestations, and hypoxia on admission were found to be significant risk factors for PICU requirement by univariate analysis. While prematurity, age below 1 year, underlying CHD, and hypoxia on admission were independent predictors for PICU admission in multivariate analysis (Table 3). No significant multicollinearity was found among the variables.

Predictive scores (range: 1–3) were developed from the β-coefficient of significant predictors in multivariate analysis and the sum scores (range: 1–9) were used to report the statistical probabilities for the requirement of PICU admission. The AUC (95% CI) was 0.869 (0.843–0.935) (Fig. 1). For the prediction of PICU admission at the cutoff, the value of sum score below 4 had 97.3% sensitivity and 97.1% NPV, whereas a cutoff value of sum score above 6 had 98.9% specificity, 89.7% PPV, 81.3% NPV, 46.2 positive likelihood ratio, and 0.83 negative likelihood ratio (Table 4).

Discussion

The RSV-associated acute lower respiratory illness, a leading cause of childhood morbidity and mortality in developing countries, has been constantly changing its epidemiology alongside the ongoing COVID-19 pandemic.[11] At the initial phases of this pandemic, most parts of the globe experienced an unprecedented reduction in childhood hospitalization with other respiratory viral illnesses including RSV-ALRI perhaps through the influence of nonpharmaceutical interventions (NPIs) such as hand-washing, mask-wearing, and maintaining physical distancing.[12] At the same time, with reduced exposure to common circulating pathogens, there was a lack of immune stimulation, children became immunologically naïve against RSV, and infants did not receive passive immunity from their mothers resulting in a delayed and larger peak of RSV-ALRI in many countries when NPIs were lifted.[12,13] In India, the RSV activity usually peaks from July through November, and prevalence among children with symptoms of acute respiratory illness ranges from 2.1% to 62.4%.[14] The current study conducted between November and February showed a higher proportion of RSV positivity among screened children. Although different print media and electronic media have persistently highlighted the delayed resurge of RSV-ALRI among hospitalized children, to the best of our knowledge this is the first scientific report from eastern India to document the possible changes in RSV-epidemiology in the recent times.

Almost 70% of our study population were infants with the majority being males (61.42%). Studies from low- and middle-income countries (LMICs) countries also found similar findings with almost 95% of children affected at least once before their second birthday.[1,14] A recent study found increased disease severity and hospitalization rate among younger infants. The authors proposed that a decline in infant and maternal immunity from lack of RSV exposure in the previous season is a likely explanation.[5]

Cough, rhinorrhea, and fever were common presenting complaints whereas, tachypnea, chest retraction, wheezing, and crepitation in the chest were predominant clinical findings similar to other Indian studies.[15,16] Hypoxia was present in 30.71% of patients and approximately 15% had extrapulmonary symptoms predominantly being altered sensorium, seizure, and shock. These could be results from hypoxic insults, respiratory failure, direct RSV effects (i.e., RSV infection of site-specific tissue), or the result of inflammatory mediators dispersed from the provoked respiratory epithelium.[17] A high index of clinical suspicion and awareness about these atypical features are of paramount importance in the early initiation of appropriate interventions to improve outcomes as well as to reduce unnecessary investigations.

Approximately 30% of children required PICU admission with the median length of stay being 7 days (IQR: 3–9 days). Among them, 71.05% required ventilatory support, and 23.68% required vasoactive medications. These findings are on the higher side compared to previous studies done during the initial phase of the COVID-19 pandemic or pre-COVID-19 era,[18–20] but quite similar to the findings done during the period of RSV resurge later on.[5] The reason may be due to increased susceptibility and severity of RSV infection in immunologically naïve children as hypothesized by other researchers[13,21] or could be attributed to referred severe cases.

About 25% of children developed complications. ARDS was the most common pulmonary complication. Neurological and then cardiovascular were common extra-pulmonary complications

Table 1: Profile of the study population ($N = 127$)

Variables	*Frequency (%)*	*Variables*	*Frequency (%)*
Age		Investigations	
<1 year	88 (69.29)	Abnormal chest radiograph	99 (77.95)
1–5 years	30 (23.62)	Hemoglobin (gm/dL), mean (SD)	9.61 (3.7)
>5 years	9 (7.09)	TLC (/µL), mean (SD)	12,877 (5,672)
Gender		Platelet (lakhs/L), mean (SD)	1.92 (0.63)
Female	49 (38.58)	CRP (mg/L), mean (SD)	15.13 (5.91)
Male	78 (61.42)	Treatment and outcome	
Residence		Received antibiotics	107 (84.25)
Rural	94 (74.02)	Received systemic steroid	17 (13.38)
Urban	33 (25.98)	Received O_2 supplementation	102 (80.31)
Preterm	27 (21.26)	O_2 requirement duration (hrs), mean (SD)	96 (42)
LBW	41 (32.28)	Required PICU admission	38 (29.92)
Significant neonatal illness	67 (52.76)	PICU stay (days), median (IQR)	7 (3–9)
Exclusive breastfeeding less than 6 months	81 (63.78)	Required mechanical ventilation	27 (21.26)
Significant smoke exposure	73 (57.48)	Required vasoactive medication	9 (7.09)
Family history of atopy	49 (38.58)	Hospital stays (days), median (IQR)	9 (2–17)
Comorbidity	42 (33.07)	Developed complication	31 (24.41)
CHD ($n = 21$)		*ARDS ($n = 12$)*	
CLD ($n = 9$)		*Encephalopathy ($n = 9$)*	
Neurological/neuromuscular ($n = 7$)		*Hypotension ($n = 9$)*	
Undernutrition/failure to thrive ($n = 3$)		*Myocarditis ($n = 6$)*	
Other ($n = 2$)		*MODS ($n = 3$)*	
Clinical signs/symptoms		*Transaminitis ($n = 2$)*	
Preadmission illness (days), median (IQR)	5 (2–8)	*Acute kidney injury ($n = 1$)*	
Fast breathing	127 (100)	*Pleural effusion ($n = 1$)*	
Cough	104 (81.89)	*Pneumothorax ($n = 1$)*	
Rhinorrhea	93 (73.23)	Expired	2 (1.57)
Fever	91 (71.65)		
Retraction	41 (32.28)		
Wheezing	47 (37.01)		
Crepitations	33 (25.98)		
Room air $SpO_2 \leq 92\%$	39 (30.71)		
Extrapulmonary manifestations	19 (14.96)		
Altered sensorium ($n = 13$)			
Features of shock ($n = 11$)			
Convulsion ($n = 3$)			
Acute gastroenteritis ($n = 2$)			

IQR, interquartile range; SD, standard deviation; TLC, total leukocyte count; CRP, C-reactive protein; PICU, pediatric intensive care unit; ARDS, acute respiratory distress syndrome; MODS, multiple organ dysfunction syndrome

similar to previous studies.[22,23] Although the pathophysiology of extrapulmonary involvement remains unclear, cytokine-storm, metabolic alteration at the cellular level following a hematogenous spread, hypoxic insults, or direct injury to blood–brain barrier and myocardium are commonly proposed mechanisms.[24]

We have studied different clinico–demographic factors for PICU admission and found that prematurity (born at <37 weeks of gestation), age below 1 year, underlying CHD, and hypoxia at admission were independent predictors of PICU admission.

A meta-analysis from eligible studies also found prematurity as a significant risk factor [AOR (95% CI): 1.75 (1.31–2.36)] for poor outcomes in children with RSV-ALRI.[25] Premature infants with a smaller diameter of airways, lower numbers of alveoli, and reduced maternal anti-RSV IgG antibodies make them susceptible to severe infection. These infants often present with apnea and lung infiltrates/atelectasis or hyperinflation in chest radiographs.

In our study, children below 1 year of age had a significantly higher risk of intensive care needs than the older ones. Previous

Table 2: Comparative analysis of the two groups

Independent predictors	*PICU group (N = 38)* *Frequency (%)*	*Non-PICU group (N = 89)* *Frequency (%)*	*Univariate p-value**
Age			
<1 year	31 (81.58)	57 (64.04)	**0.049**
1–5 years	5 (13.16)	25 (28.09)	0.696
>5 years	2 (5.26)	7 (7.87)	–
Gender			
Female	18 (47.37)	31 (34.83)	0.183
Male	20 (52.63)	58 (65.17)	–
Residence			
Rural	24 (63.16)	70 (78.65)	0.068
Urban	14 (36.84)	19 (21.35)	–
Preterm	17 (44.74)	10 (11.23)	<**0.001**
LBW	19 (50.0)	22 (24.72)	**0.005**
Significant neonatal illness	16 (42.11)	51 (57.30)	0.116
Exclusive breastfeeding less than 6 months	20 (52.63)	61 (68.54)	0.087
Significant smoke exposure	27 (71.05)	46 (51.69)	**0.043**
Family history of atopy	18 (47.37)	31 (34.83)	0.225
Comorbidity	23 (60.52)	19 (21.35)	
CHD	13 (34.21)	8 (8.99)	<**0.001**
CLD	6 (15.79)	3 (3.37)	**0.014**
Neurological/Neuromuscular	3 (7.89)	4 (4.49)	0.463
Undernutrition/Failure to thrive	1 (2.63)	2 (2.25)	0.089
Other	0	2 (2.25)	–
Clinical signs/symptoms			
Preadmission illness (days), median (IQR)	3 (2–5)	4 (3–8)	0.254
Cough	34 (89.47)	70 (78.65)	0.255
Rhinorrhea	24 (63.16)	69 (77.53)	0.093
Fever	26 (68.42)	65 (73.03)	0.464
Retraction	27 (71.05)	14 (15.73)	**0.010**
Wheezing	18 (36.84)	29 (32.58)	0.114
Crepitations	12 (31.57)	21 (23.59)	0.347
Room air SpO_2 ≤92%	18 (47.37)	21 (23.59)	**0.007**
Extrapulmonary manifestations	14 (36.84)	5 (5.62)	<**0.001**
Investigation			
Abnormal chest radiograph	34 (89.47)	65 (73.03)	0.051
Hemoglobin (gm/dL), mean (SD)	9.54 (3.41)	9.81 (4.13)	0.692
Total leukocyte count (/µL), mean (SD)	12,987 (6,213)	12,766 (5,312)	0.839
Platelet (lakhs/L), mean (SD)	1.91 (0.67)	1.93 (0.59)	0.867
CRP (mg/L), mean (SD)	16.13 (6.21)	13.91 (5.82)	0.057
Treatment and outcome			
Received antibiotics	36 (94.74)	71 (79.78)	0.378
Received systemic steroid	9 (23.68)	8 (8.99)	0.052
Required O_2 supplementation	38 (100)	64 (71.91)	<**0.001**
O_2 requirement duration (hrs), mean (SD)	108 (48)	72 (36)	<**0.001**
PRISM-III scores, median (IQR)	17 (13–19)	10 (7–14)	<**0.001**
pSOFA score, median (IQR)	11 (9–12)	7 (6–10)	<**0.001**
Hospital stays (days), median (IQR)	12 (5–12)	5 (2–6)	<**0.001**
Developed complication	27 (71.05)	4 (0.04)	<**0.001**
Expired	2 (19)	0 (0)	–

Bold values denote statistically significant *p*-values (<0.05); *Using Chi-squared test, Fisher exact test, Student's *t*-test, and Mann–Whitney U test as appropriate. PICU, pediatric intensive care unit; IQR, interquartile range; SD, standard deviation; CRP, C-reactive protein; PRISM III, pediatric risk of mortality score; pSOFA, pediatric sequential organ failure assessment

Table 3: Multivariate logistic regression model to develop predictive scores

	Multivariate analysis			
Independent predictors	*AOR (95% CI)*	*p-value*	*β-coefficient*	*Score*
Prematurity	2.71 (1.79–4.61)	**0.021**	1.58	2
LBW	3.95 (0.94–12.91)	0.067		
Age below 1 year	1.33 (1.03–3.61)	**0.047**	1.02	1
Significant smoke exposure	1.24 (0.23–5.16)	0.178		
CHD	3.91 (1.63–5.39)	**<0.001**	1.89	3
CLD	1.63 (0.44–6.01)	0.217		
Retraction	1.21 (0.77–1.95)	0.395		
Room air SpO_2 ≤92%	8.19 (5.36–13.16)	**0.013**	2.41	3
Extrapulmonary manifestations	1.109 (0.83–2.11)	0.051		

Bold values denote statistically significant *p*-values (<0.05); AOR, adjusted odds ratio; CI, confidence interval

Table 4: Performance of sum scores to predict PICU admission

Sum score	*Sensitivity (95% CI)*	*Specificity (95% CI)*	*PPV (95%CI)*	*NPV (95% CI)*	*LR^+ (95% CI)*	*LR^- (95% CI)*
<4	0.973 (0.861–0.988)	0.527 (0.483–0.547)	0.419 (0.342–0.438)	0.971 (0.847–0.983)	1.672 (1.365–2.019)	0.059 (0.017–0.158)
4–6	0.653 (0.521–0.673)	0.860 (0.821–0.882)	0.849 (0.809–0.861)	0.846 (0.821–0.859)	13.057 (12.001–14.537)	0.563 (0.541–0.692)
>6	0.414 (0.386–0.447)	0.989 (0.887–0.993)	0.897 (0.813–0.931)	0.813 (0.771–0.830)	46.217 (44.917–47.998)	0.832 (0.801–0.916)

PPV, positive predictive value; NPV, negative predictive value, LR^+, positive likelihood ratios; LR^-, negative likelihood ratio; CI, confidence interval

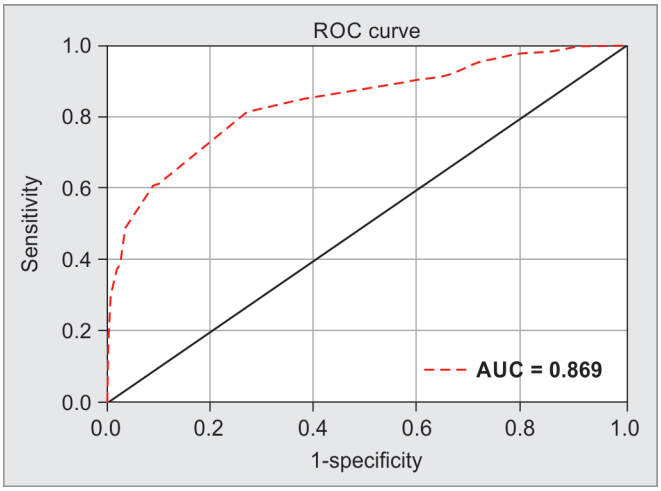


Fig. 1: An ROC curve depicting AUC of sum scores to predict PICU admission

studies from LMICs also found increased disease severity and RSV-related mortality among younger infants.[1,26,27] It is believed that natural maternal immunity is not enough to prevent severe RSV-ALRI and because of having an immature immune system in early infancy, they are unable to produce adequate cellular and antibody response during the acute phase of RSV infection.

Underlying CHD in RSV-infected children has been well recognized for more severe outcomes, including higher hospitalization rates, longer hospital stays, need for intensive care unit admission or mechanical ventilation, and mortality. Children with RSV-ALRI having underlying CHD had almost 4 times (95% CI: 3.4–4.5) higher risk of PICU admission in previous studies.[28] Immune prophylaxis with RSV-specific monoclonal antibodies may result in better outcomes in these children.[29]

Hypoxia on admission was found to be an important risk factor for severe illness in children with ALRI.[30,31] Similarly, it was an independent predictor for PICU admission in our study. RSV initiates an inflammatory cascade in peribronchiolar tissues, leading to increased microvascular permeability, submucosal edema and swelling, loss of ciliated epithelium, and widespread mucous plugging. Progressive hypoxemia, carbon dioxide retention and respiratory acidosis signal the development of respiratory muscle fatigue and evolving respiratory failure.[32]

A novel scoring system developed from these independent predictors has excellent predictive strength to anticipate the PICU need as depicted by the AUC (95% CI) of 0.869 (0.843–0.935). Previous researchers from LMICs have attempted to develop similar algorithms to assist in clinical diagnosis, evaluation, or forecast severity of different infectious diseases.[33–36] To the best of our knowledge, this is the first study from eastern India to develop a scoring system on such a precious but less discussed child health issue. The current score also has an excellent NPV at a sum score of below 4, highlighting its ability to rule out the possibility of PICU requirement whereas the sum score above 6 has high specificity, PPV, and positive likelihood for PICU need. We propose that clinicians even in busy emergencies can use this simple tool to asses these children and those with sum score below 4 can be managed in the general ward whereas children with sum score above 6 should be managed in PICU.

Strengths and Limitations

This study is the first to report the current changes in the clinico–epidemiological pattern of RSV-ALRI in children from eastern India. It will help public health policymakers to design strategies with available resources to manage this new epidemic alongside the ongoing COVID-19 pandemic. The results of this study are encouraging and many life-saving decisions regarding emergency child care can be made easier, faster, and even more efficiently by

using the simple scoring system. Limitation includes a single-center study with a small sample size and exact seasonality that couldn't be studied due to the limited study period. Due to the lack of a reference study from this region, the sample size was not calculated and all the eligible candidates were included. A multicenter prospective study with active RSV surveillance throughout the year is of utmost necessity to understand the recent changes in RSV epidemiology and generalize our findings to a larger population.

Conclusion

Our study is a snapshot of the recent outbreak of RSV-ALRI among children in eastern India showing a higher need for PICU admission. Prematurity, age below 1 year, underlying CHD, and hypoxia at admission were the independent predictors of PICU admission. It will be beneficial for busy clinicians in planning the level of care needed by using the simple scoring system and thereby optimizing PICU resources. External validation of the score is essential before implementing it into routine practice.

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