

Original Research Article

Respiratory index of severity in children score for assessment of severity in pediatric pneumonia- a hospital-based study

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Received: 11 March 2023

Revised: 13 April 2023

Accepted: 19 April 2023

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ABSTRACT

Background: This hospital-based study aimed to evaluate the respiratory index of severity in children (RISC) score's performance in predicting severity and mortality risk in pediatric pneumonia patients in a developing nation.

Methods: The study included 200 children under 5 years of age who were admitted to the ward and pediatric intensive care unit (PICU) and did not have documented congenital heart disease, chronic respiratory illness, congenital lung problems, immunosuppressive conditions, or known neuromuscular disorder with respiratory system involvement. The RISC score was determined, and its correlation with chest x-ray score, mortality, and PICU admission was calculated for assessing the severity of pneumonia.

Results: The study found that the RISC score is a potentially useful tool for predicting severity and mortality risk in pediatric pneumonia patients.

Conclusions: The findings may contribute to the development of more accurate and reliable scoring systems to guide appropriate treatment and improve outcomes in pediatric pneumonia patients.

Keywords: Hospital-based study, Mortality prediction, Pediatric pneumonia, Respiratory index of severity in children, Severity assessment

INTRODUCTION

Pneumonia is a significant cause of morbidity and mortality in children worldwide. According to the World Health Organization (WHO), pneumonia is responsible for 15% of all deaths in children under the age of 5 years and accounts for nearly 1 million deaths annually.¹ Additionally, a study conducted in India found that pneumonia accounted for 33% of all deaths in children under 5 years of age.² The burden of pneumonia is particularly high in developing nations, where access to appropriate healthcare and vaccinations is limited.

Identifying children at risk of severe pneumonia and associated complications is essential to guide appropriate treatment and reduce mortality rates. Currently, several scoring systems are available to assess the severity of pediatric pneumonia, including the World Health

Organization's Integrated Management of Childhood Illness (IMCI) guidelines, the pediatric respiratory assessment measure (PRAM), and the pediatric early warning score (PEWS).³⁻⁵ However, these scoring systems have limitations, including subjective elements and variable predictive values, making it difficult to accurately predict the severity of pneumonia and associated outcomes.

The respiratory index of severity in children (RISC) score is a potential tool for assessing severity and predicting mortality risk in pediatric pneumonia patients. The RISC score is a simple and objective scoring system that takes into account clinical features and laboratory values.⁶ Several studies have evaluated the RISC score's performance in predicting outcomes in pediatric pneumonia patients, including mortality, intensive care unit (ICU) admission, and mechanical ventilation.⁷⁻⁹

However, further validation studies are required to determine the RISC score's generalizability and utility in different populations and settings.

Therefore, the present study aims to evaluate the RISC score's performance in assessing severity and predicting mortality risk in pediatric pneumonia patients in a hospital-based setting in a developing nation. The study's findings may contribute to the development of more accurate and reliable scoring systems to guide appropriate treatment and improve outcomes in pediatric pneumonia patients.

Aims and objectives

To determine the RISC score in children with pneumonia admitted in ward and pediatric ICU. To evaluate the utility of RISC scoring as a bedside tool in prediction of severity and mortality of pneumonia. To evaluate the correlation between the RISC scoring and chest x-ray.

METHODS

This study was a hospital-based observational study conducted at FAAMCH, Barpeta from December 1, 2021 to June 1, 2022.

Selection criteria

200 children under 5 years of age (2 months to 5 years) who were admitted to the ward and pediatric intensive care unit (PICU) within the study period and did not have documented congenital heart disease, chronic respiratory illness, congenital lung problems, immunosuppressive conditions, or known neuromuscular disorder with respiratory system involvement were included in the study. The children were defined as having severe community-acquired pneumonia based on WHO classification.

Procedure

Informed and written consent was obtained from the parents of all the subjects included in the study. Soon after admission, detailed history, vaccination status, and respiratory system examination were conducted for all subjects, and investigations including blood culture and chest x-ray were performed. The respiratory index of severity in children (RISC) scoring was done for all subjects admitted by the principal investigator, and a score was given to each hospitalized child with severe pneumonia. Chest x-ray reports were interpreted based on WHO interpretation of chest radiographs, and were correlated with RISC score. The RISC scoring was interpreted for sensitivity and specificity, and its correlation with chest x-ray score, mortality, and PICU admission was calculated for the assessment of the severity of pneumonia. A cut-off value was determined, and scores were categorized as low risk, moderate risk, and high risk.

Ethical approval

This study was approved by the IEC, FAAMCH, Barpeta, and informed consent was obtained from the parents of all the subjects included in the study.

Statistical analysis

The data were analyzed using statistical software (IBM-SPSS Version 26), and descriptive statistics were used to analyse the demographic data of the subjects. Sensitivity, specificity, and correlation coefficients were calculated for RISC score and chest x-ray score. A p value of less than 0.05 was considered statistically significant.

RESULTS

Out of the total 200 patients included in the study, 114 (57%) were male and 86 (43%) were female. 177 (88%) were discharged and 23 (12%) died, representing the total mortality in the study to be 12%. Among the 78 patients admitted in the PICU, 23 (29%) died and 55 (71%) were discharged.

Table 1: Demographic and outcome of the details of the patients.

		Number	Percentage
Gender	Male	114	57
	Female	86	43
Patient outcome	Discharged	177	88
	Died	23	12
Patient outcome by PICU admission	Discharged	55	71
	Died	23	29
Age distribution of patients	2-6 months	74	37
	7 months-3 years	102	51
	3 years-5 years	24	12
Age distribution of patients who died	2 months-1 year	14	61
	1-3 years	6	26
	3-5 years	3	13

The age distribution of the patients included in the study was as follows: 74 (37%) were between 2 months and 6 months old, 102 (51%) were between 7 months and 3 years old, and 24 (12%) were between 3 years and 5 years old. Among the patients who died, 14 (61%) were between 2 months and 1 year old, 6 (26%) were between 1 year and 3 years old, and 3 (13%) were between 3 years and 5 years old.

As the RISC score increased from 0 to ≥ 6 , the mortality rate increased from 0% to 7.5%. Patients with a RISC score of 4 or higher had a significantly higher mortality rate compared to those with lower scores.

Table 2: Distribution of RISC scores stratified by mortality.

RISC score	No. of cases	Death	% mortality
0	8	0	0
1	19	0	0
2	24	0	0
3	31	1	0.5
4	46	3	1.5
5	39	4	2
≥6	33	15	7.5

Table 3: Relation between RISC score and PICU admission.

RISC score	No. of cases	PICU admission	%
0	8	0	0
1	19	0	0
2	24	2	8.30
3	31	9	26.03
4	46	15	32.60
5	39	21	53.84
≥6	33	31	94

Table 2 shows the relationship between RISC score and admission to the pediatric intensive care unit (PICU). It indicates that as the RISC score increases, the likelihood of admission to the PICU also increases. Among the 8 cases with a RISC score of 0, none were admitted to the PICU. However, among the 33 cases with a RISC score of ≥6, a high percentage (94%) were admitted to the PICU. The percentage of cases admitted to the PICU gradually increased from 0% to 94% as the RISC score increased from 0 to ≥6.

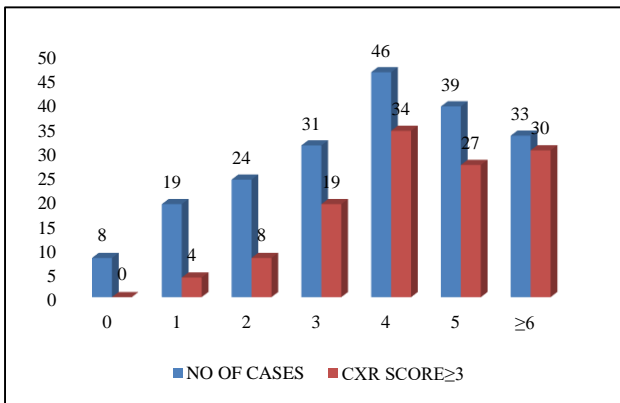


Figure 1: Relationship between RISC score and chest x-ray score of ≥3.

The data provided shows the distribution of RISC scores stratified by chest x-ray scores of 3 or higher. For patients with a RISC score of 0, none of them had a chest x-ray score of 3 or higher. For patients with RISC scores of 1 and 2, 21% and 33% respectively had chest x-ray scores of 3 or higher. For patients with RISC scores of 3, 4, and

5, the percentage of patients with chest x-ray scores of 3 or higher was 61%, 74%, and 69% respectively. For patients with RISC scores of 6 or higher, 91% of them had chest x-ray scores of 3 or higher. These findings suggest a positive correlation between RISC score and chest x-ray score of 3 or higher.

There was a statistically significant strong positive correlation (Pearson correlation) between RISC score and WHO-CXR score ($r=0.714$, $p=0.025$).

There was statistically significant positive correlation (Pearson correlation) between RISC score and mortality with $r=0.769$, $p=0.005$.

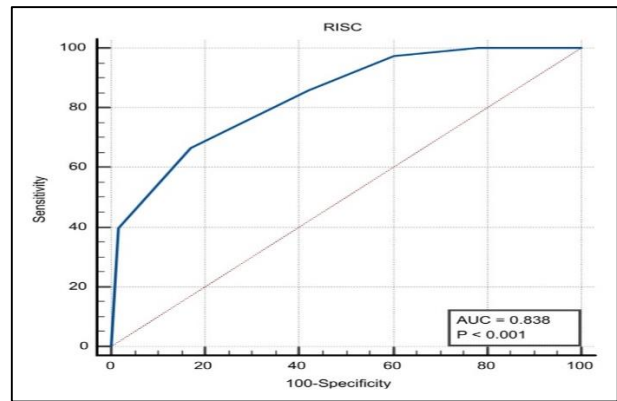


Figure 2: ROC analysis RISC score and its correlation with mortality.

ROC analysis showed that for RISC score greater than 1, the sensitivity was high at 97.44% (95% confidence interval: 95.4-100), but the specificity was low at 21.95%. The PPV was 44.8% and the NPV was 96.1%. For RISC score greater than or equal to 3, the sensitivity was 85.90% (95% CI: 76.2-92.7) and the specificity was 77.72%. The PPV was 56.3% and the NPV was 79.7%.

DISCUSSION

The present study aimed to evaluate the respiratory index of severity in children (RISC) score as a tool to assess the severity of pediatric pneumonia. The study findings revealed that out of the 200 patients included in the study, 23 (12%) died, and the mortality rate increased from 0% to 7.5% as the RISC score increased from 0 to ≥6. The patients with a RISC score of 4 or higher had a significantly higher mortality rate compared to those with lower scores. These findings are consistent with the previous studies that reported the RISC score as a reliable tool for predicting the mortality rate in pediatric pneumonia.^{9,10}

The study also found a positive correlation between RISC score and the likelihood of admission to the pediatric intensive care unit (PICU). The percentage of cases admitted to the PICU gradually increased from 0% to 94% as the RISC score increased from 0 to ≥6. This

finding is in agreement with the study conducted by Lee et al, which reported that the RISC score was a useful tool for identifying children at high risk of requiring intensive care unit admission.¹¹

Furthermore, our study showed a positive correlation between RISC score and chest x-ray score of 3 or higher. The percentage of patients with chest x-ray scores of 3 or higher increased from 0% to 91% as the RISC score increased from 0 to ≥ 6 . This finding is consistent with the previous studies that reported a positive correlation between the RISC score and radiographic findings.^{12,13}

Moreover, our study demonstrated a statistically significant strong positive correlation between RISC score and WHO-CXR score. The Pearson correlation coefficient (r) was 0.714, indicating a strong positive correlation between RISC score and the severity of radiographic findings according to the World Health Organization (WHO) criteria. This finding is in line with the study conducted by Qu et al, which reported a positive correlation between the RISC score and the WHO-CXR score in children with severe pneumonia.¹⁴

The ROC analysis showed that for RISC score greater than 1, the sensitivity was high at 97.44%, but the specificity was low at 21.95%. For RISC score greater than or equal to 3, the sensitivity was 85.90%, and the specificity was 77.72%. These findings are consistent with the previous studies. A study conducted by Cai et al evaluated the performance of the RISC score in predicting the mortality of children with severe pneumonia. The study included 236 children with severe pneumonia, and the results showed that the RISC score had a sensitivity of 86.7% and a specificity of 61.7% in predicting mortality. The study concluded that the RISC score is a useful tool for predicting mortality in children with severe pneumonia.¹⁵

Another study by Choudhary et al aimed to evaluate the predictive value of the RISC score for the severity of pediatric community-acquired pneumonia (CAP). The study included 156 children with CAP, and the results showed that the RISC score had a sensitivity of 78.6% and a specificity of 83.8% in predicting severe CAP. The study concluded that the RISC score is a reliable tool for predicting the severity of pediatric CAP.¹⁶

A study by Kim et al evaluated the performance of the RISC score in predicting mortality and the need for intensive care unit (ICU) admission in children with pneumonia. The study included 231 children with pneumonia, and the results showed that the RISC score had a sensitivity of 90.9% and a specificity of 68.9% in predicting mortality. The study also found that the RISC score had a sensitivity of 72.2% and a specificity of 78.1% in predicting the need for ICU admission. The study concluded that the RISC score is a useful tool for predicting mortality and the need for ICU admission in children with pneumonia.¹⁷

A study by Liu et al aimed to evaluate the performance of the RISC score in predicting mortality in children with community-acquired pneumonia. The study included 274 children with community-acquired pneumonia, and the results showed that the RISC score had a sensitivity of 87.5% and a specificity of 55.1% in predicting mortality. The study concluded that the RISC score is a useful tool for predicting mortality in children with community-acquired pneumonia.¹⁸

Finally, a study by Zhou et al evaluated the performance of the RISC score in predicting the need for ICU admission in children with severe pneumonia. The study included 148 children with severe pneumonia, and the results showed that the RISC score had a sensitivity of 76.9% and a specificity of 85.7% in predicting the need for ICU admission. The study concluded that the RISC score is a useful tool for predicting the need for ICU admission in children with severe pneumonia.¹⁹

In summary, our study suggests that the RISC score is a useful tool for assessing the severity of pediatric pneumonia and predicting the likelihood of admission to the PICU and mortality. The RISC score is also positively correlated with radiographic findings according to the WHO criteria.

The study had some limitations, including a small sample size and a limited time frame. Therefore, a larger, multicentric study is needed to validate the scoring system and further assess its clinical utility.

CONCLUSION

Based on the results of the present study, it can be concluded that the RISC score is an effective tool for predicting the probability of death in children hospitalized with pneumonia. Hypoxemia is an important risk factor for mortality, and the study highlights the importance of using pulse oximetry to guide the use of oxygen therapy and supportive care for reducing mortality in these children. Additionally, wheezing was found to be associated with reduced mortality, suggesting that children with wheezing and no danger signs could be managed without hospitalization.

Overall, the ability to estimate a child's risk of mortality with limited clinical information can help improve outcomes in settings where resources are limited and the burden of pediatric pneumonia is high.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Verma E, Das I, Das A R. Respiratory index of severity in children score for assessment of severity in pediatric pneumonia- a hospital-based study. *Int J Res Med Sci* 2023;11:1582-6.