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# Comparison of Modified Predisposition, Insult, Response, Organ dysfunction (PIRO) score and Respiratory Index of Severity in Children (RISC) score in prediction of severity of paediatric pneumonia: A cross-sectional comparative study

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## ABSTRACT

**Background:** Pneumonia remains a leading cause of morbidity and mortality in children, especially in low- and middle-income countries. Early identification of severe cases is essential to improve outcomes. This study aimed to evaluate the prognostic utility of two pediatric pneumonia severity scoring systems, modified PIRO and RISC in a tertiary care setting in South India.

**Objectives:** To compare modified PIRO scoring system with RISC scoring system in prediction of severity of pneumonia in children in a tertiary care hospital in Kolar.

**Methodology**: This cross-sectional comparative study was conducted in RL Jalappa Hospital, Department of Pediatrics between March 2025 to May 2025.Children who came to the hospital with pneumonia were included in this study. The collected data underwent statistical analysis.

**Results:** Of the 80 patients, 23 (28.8%) were categorized as severe by the modified PIRO score, with a mortality rate of 47.8%. The Modified PIRO score demonstrated a sensitivity of 84.6%, specificity of 82.0% and a negative predictive value (NPV) of 96.4%. In comparison, 29 patients (36.2%) had a RISC score ≥3, with a 34.5% mortality rate, sensitivity of 76.9%, specificity of 71.6% and NPV of 94.1%. Both scoring systems showed a statistically significant association with outcomes ($p < 0.001$).

**Conclusion:** The modified PIRO score showed superior prognostic performance and is better suited for hospital-based triage due to its comprehensive, multi-system assessment. The RISC score, though slightly less predictive, offers practical value in low-resource settings as a simple, clinical tool. A context-sensitive, stratified triage approach using these scoring systems can enhance the management and outcomes of pediatric pneumonia.

***Keywords:*** *Pediatric Pneumonia, Modified Piro Score, Respiratory Index Of Severity In Children Score, Risk Stratification*

## 1. INTRODUCTION

Pneumonia is the leading cause of death among children worldwide, responsible for over 800,000 deaths in children under five years of age in 2017 [1,2]. According to data from the Ministry of Health and Family Welfare, Government of India, for the period 2022–2023, pneumonia accounted for approximately 17.5% of deaths among children under the age of five, making it one of the leading causes of mortality in this age group. Pneumonia can vary widely in severity, from mild illness to life-threatening conditions. Typical clinical manifestations include fever, cough, rapid breathing (tachypnea), breathing difficulties, wheezing, headache, abdominal discomfort and chest pain. According to the revised Integrated Management of Childhood Illness (IMCI) guidelines by the World Health Organization (WHO), pneumonia is categorized into three levels:

no pneumonia (characterized by cough and/or cold), pneumonia (indicated by fast breathing and/or chest indrawing) and severe pneumonia (marked by general danger signs such as inability to drink, persistent vomiting, convulsions, lethargy, stridor in a calm child or severe malnutrition). Assessing clinical symptoms, physical signs and relevant risk factors is essential for anticipating disease progression and determining which children may need hospitalization or intensive care unit (ICU) admission [3]. Scoring systems can help evaluate the severity of pneumonia. Various tools, including the Pneumonia Severity Index (PSI), CURB-65, CRB-65, SMART-COP and PIRO (Predisposition, Insult, Response, Organ dysfunction) are commonly used in adults to assess disease severity [4,5,6]. However, there are relatively few scoring systems designed specifically for assessing pneumonia severity in children. Some scoring systems developed specifically for the pediatric age group, such as the modified PIRO (Predisposition, Insult, Response, Organ Dysfunction) and the Respiratory Index of Severity in Children (RISC) can be utilized to assess the severity and predict clinical outcomes in children with pneumonia.

## 2. MATERIALS AND METHODS

This is a cross-sectional comparative study conducted in RL Jalappa Hospital, Department of Pediatrics between March 2025 to May 2025. The study was proceeded after taking the institutional ethical clearance. Children who came to the hospital with pneumonia were included in this study. Relevant clinical and laboratory data was collected. Both modified PIRO scoring system and RISC scoring system were applied. The collected data underwent statistical analysis.

**Inclusion criteria:**

- ✧ Children aged between 1 month to 18 years visiting the hospital with pneumonia.

**Exclusion criteria:**

- ✧ Children with upper respiratory tract infections or bronchiolitis or laryngotracheobronchitis.
- ✧ Children with history of liver, kidney and coagulation disorders.
- ✧ Children with documented congenital heart disease.
- ✧ Children with chronic respiratory illness.
- ✧ Children with congenital lung problems.
- ✧ Children with immunosuppressive conditions or known to have neuromuscular disorders with respiratory system involvement.
- ✧ Children whose parents did not consent for the study.

This study was started after obtaining ethical clearance from the institutional ethical committee as well as consent from the parents.

Pneumonia was defined as a lower respiratory tract infection presenting with fever, respiratory symptoms, and pulmonary parenchymal involvement on physical exam or chest radiograph [7]. As per IMCI classification by WHO, pneumonia was classified into no pneumonia, pneumonia and severe pneumonia. Paediatric patients meeting inclusion criteria were assessed at admission using two validated severity scoring systems: the modified PIRO and RISC scores.

Data collected included patient demographics, clinical presentation, past history and examination findings. Relevant blood investigations and chest radiographs were obtained to confirm diagnosis and score severity.

The modified PIRO score comprised four components:

- Predisposition (malnutrition defined as weight-for-length/height < -2 SD or BMI < 3rd percentile),
- Insult (complicated chest X-ray: multi-lobar infiltrates, empyema or effusion),
- Response (hypoxemia: $SpO_2$ < 90%, hypotension: systolic blood pressure < 5th percentile, CRP > 0.5 mg/dL and Procalcitonin > 0.5 ng/mL),
- Organ dysfunction (per International Paediatric Sepsis Consensus Conference criteria) [8]. Each variable was scored 0 or 1; total scores were stratified as low (<2), moderate (3–4), or high (5–7) risk.

The RISC score included $SpO_2$ < 90% (3 points), chest indrawing (2 points), wheezing (-2 points), refusal to feed (1 point) and weight-for-age (< -3 SD = 2 points; between -3 and -2 SD = 1 point). Scores were categorized as low (< 1), moderate (2) or high ($\geq$ 3) risk.

All data were compiled in Excel sheet and analysed using SPSS to compare the predictive performance of the modified PIRO and RISC scores in relation to patient outcomes.

## 3. RESULTS

The median age of the study participants in this study was 7.9 ± 3.7 years. Majority of the subjects were males (50, 62.5%) in this study.

Modified PIRO score was applied and out of the 80 patients studied, 36 patients (45%) were classified as mild, 21 patients (26.2%) had moderate scores and 23 patients (28.8%) were in the severe category.

- Distribution of modified PIRO scores(n=80)

| Modified PIRO Score | No. of patients | Percentage |
|---|---|---|
| Mild | 36 | 45.00% |
| Moderate | 21 | 26.20% |
| Severe | 23 | 28.80% |
| Total | 80 | 100.00% |

Out of the 80 patients studied, 29 patients (36.2%) had a RISC score greater than or equal to 3, indicating higher severity. 51 patients (63.8%) had a RISC score of less than 3, suggesting a lower risk. This shows that most patients fell into the lower risk category based on RISC scoring.

- Distribution of RISC scores(n=80)

| RISC Score | No. of patients | Percentage |
|---|---|---|
| Severe | 29 | 36.20% |
| Mild to moderate | 51 | 63.80% |
| Total | 80 | 100.00% |

Among all 80 patients, 67 patients (83.5%) were discharged and 13 patients (16.3%) unfortunately passed away.

- Distribution of outcome(n=80)

| Outcome | No. of patients | Percentage |
|---|---|---|
| Discharged | 67 | 83.50% |
| Death | 13 | 16.30% |

Association between modified PIRO Score and outcome:

Of those in the severe PIRO category, 47.8% died. In contrast, only 3.5% of those with mild or moderate PIRO scores died. The association is highly significant (p = 0.0001), showing that a severe PIRO score strongly predicts poor outcomes.

- Distribution of outcome for modified PIRO scores(n=80)

| PIRO Score | Outcome | | | p - value |
|---|---|---|---|---|
| | Death | Discharged | Total | |
| Severe | 11 (47.8%) | 12 (52.2%) | 23 | 0.0001 |
| Mild & Moderate | 2 (3.5%) | 55 (96.5%) | 57 | |
| Total | 13 | 67 | 80 | |

**Diagnostic value of modified PIRO score:**

Sensitivity: 84.6% (ability to correctly identify those who died)

Specificity: 82.0%(ability to correctly identify those who survived)

PPV: 47.8%(chance of death if score in severe category)

NPV: 96.4%(chance of survival if score in low to moderate category)

The high NPV indicates that patients with mild/moderate PIRO scores are very likely to survive.

**Association between RISC Score and outcome:**

Among those with a RISC score ≥3, about one-thirds had died (36.2%). In contrast, only 5.9% of those with a RISC score < 3 died. The p-value = 0.0008 shows this is statistically significant, meaning there's a strong link between a higher RISC score and increased risk of death.

- Distribution of outcome for RISC scores(n=80)

| RISC Score | Outcome | | | p - value |
|---|---|---|---|---|
| | Death | Discharged | Total | |
| Severe | 10 (34.5%) | 19 (65.5%) | 29 | 0.0008 |
| Mild to moderate | 3 (5.9%) | 48 (94.1%) | 51 | |
| Total | 13 | 67 | 80 | |

**Diagnostic value of RISC score:**

Sensitivity: 76.9% (ability to correctly identify those who died)

Specificity: 71.6% (ability to correctly identify those who survived)

PPV: 34.4% (chance of death if score ≥3)

NPV: 94.1% (chance of survival if score < 3)

This suggests the RISC score is quite reliable in ruling out death when the score is low.

## 4. DISCUSSION

Pneumonia remains a significant public health concern and a leading cause of paediatric mortality, especially in low- and middle-income countries. In India, pneumonia was responsible for approximately 17.5% of deaths in children under five during 2022–2023, underscoring the critical need for effective clinical assessment and management strategies.

Early identification of children at risk of severe pneumonia is crucial. Clinical features alone may be insufficient to predict outcomes, especially in resource-limited settings. Scoring systems like the modified PIRO and RISC were developed to bridge this gap, aiming to stratify risk and guide treatment decisions.

In our study, we evaluated and compared the modified PIRO and RISC scoring systems in 80 paediatric patients with pneumonia. The modified PIRO score incorporates four domains: predisposition, insult, response and organ dysfunction—adapted for children based on criteria including malnutrition, complicated radiographs, hypoxemia, inflammatory markers and organ dysfunction as per IPSCC definitions. The RISC score is a simpler tool designed for use in young children in low-resource settings, weighing clinical features such as oxygen saturation, chest indrawing, wheezing, feeding difficulty and weight-for-age.

Our findings indicate that both scoring systems have clinical utility in predicting severity and outcomes. A severe PIRO score was significantly associated with mortality, with 47.8% of patients in this group succumbing to illness, compared to only 3.5% in the mild/moderate group (p = 0.0001). The modified PIRO score demonstrated high sensitivity (84.6%) and specificity (82.0%), with an impressive negative predictive value (NPV) of 96.4%, making it a reliable tool for identifying low-risk patients who are likely to survive.

Similarly, the RISC score showed a significant association with mortality, as 34.5% of those with scores ≥3 died, compared to just 5.9% among those with lower scores (p = 0.0008). While its sensitivity (76.9%) and specificity (71.6%) were slightly lower than those of the modified PIRO, the RISC score also showed a strong NPV of 94.1%, supporting its utility in ruling out severe disease.

The slightly superior performance of the modified PIRO score in our study may be attributed to its inclusion of laboratory and radiographic findings, allowing for a more comprehensive clinical assessment. However, this also limits its use in settings where such diagnostics are unavailable. In contrast, the RISC score, relying solely on bedside clinical assessment, offers a feasible alternative in resource-constrained environments.

These findings align with previous research validating both scoring systems in paediatric populations. Araya et al. and Valentania et al. demonstrated that the PIRO score can effectively stratify mortality risk in hospitalized children with pneumonia [9,10.] While studies by Reed et al. and Pillai et al. support the clinical utility of the RISC score in predicting

pneumonia severity [11,12.]

Limitations of this study include a relatively small sample size and single-centre design, which may affect generalizability. Additionally, the study did not assess long-term outcomes or the impact of interventions based on risk stratification.

## 5. CONCLUSION

The Modified PIRO score is more appropriate for hospital-based triage, especially in settings equipped with laboratory and radiographic facilities, whereas the RISC score is better suited for community-based screening and initial assessment in resource-limited environments due to its reliance solely on clinical findings. To conclude, this study highlights the value of a stratified triage approach, endorsing Modified PIRO for resource-rich settings and RISC for community use, to enhance context-specific management of paediatric pneumonia. Larger multicentre studies are needed to validate and refine these tools for broader clinical use.

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