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Original Research Article

Evaluating the efficacy of the SICK score in predicting clinical outcomes among paediatric patients presenting to the emergency department of a tertiary care centre in Kerala

Akhil Joshy*, Bincy Varghese, Jacob Abraham, Carol S. Cherian

Department of Paediatrics, Pushpagiri Institute of Medical Sciences and Research Centre, Thiruvalla, Kerala, India

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***Correspondence:**
Dr. Akhil Joshy,
E-mail: akhil.joshy116@gmail.com

ABSTRACT

Background: Early risk stratification in the paediatric emergency department (ED) is crucial for optimal resource use and prevention of avoidable mortality. The signs of inflammation in children that kill (SICK) score is a bedside tool based on observable physiological parameters. However, evidence regarding its role in guiding level-of-care decisions and its association with hospital stay is limited. This study evaluated its ability to predict pediatric intensive care unit (PICU) admission and its correlation with length of stay.
Methods: This prospective observational study was conducted over 18 months in a tertiary pediatric ED in Kerala. A total of 340 children aged 1 month to 12 years were consecutively enrolled. SICK scores were calculated at presentation. Patients were triaged to ward or PICU based on clinical assessment. Data were analyzed using descriptive statistics, independent t-test, chi-square test, Pearson correlation, and ROC curve analysis. A p value <0.05 was considered significant.
Results: Of 340 children, 40 (11.8%) required PICU admission. PICU patients were younger (43.8 versus 74.0 months; p<0.001). Mean SICK score was higher in the PICU group (5.23±1.69 versus 2.62±2.11; p<0.001). Hospital stay was longer in PICU patients (9.13±2.61 versus 2.62±1.15 days; p<0.001). SICK score showed a moderate positive correlation with length of stay (r=0.324; p<0.001). ROC analysis showed good discrimination (AUC=0.820; 95% CI: 0.756–0.884), with an optimal cut-off ≥3.5 (sensitivity 90.0%, specificity 71.7%).
Conclusions: The SICK score is a reliable tool for predicting PICU admission and correlates with hospital stay, supporting its use in paediatric ED triage, especially in resource-limited settings.

Keywords: SICK score, Paediatric emergency, Risk stratification, PICU admission, Triage, Length of hospital stay, Critical illness, Resource-limited settings, Bedside scoring, Kerala

INTRODUCTION

Paediatric critical illness remains a major contributor to global childhood morbidity and mortality. Current United Nations estimates indicate that more than 2.4 billion individuals worldwide are below the age of 18, with India alone contributing approximately 345.6 million children aged 0–14 years, representing nearly 24% of its population.[1,2] This vast paediatric demographic, combined with a high burden of acute respiratory infections, sepsis, gastroenteritis, and neurological emergencies, places considerable demand on paediatric emergency services and intensive care infrastructure.

Paediatric emergencies require rapid, structured clinical assessment because children can compensate physiologically during early deterioration and decompensate with alarming speed, often with delayed presentation and limited diagnostic resources. The initial evaluation framework employing the paediatric assessment triangle, the ABCDE approach, and recognition of danger signs allows clinicians to identify life threatening abnormalities rapidly before formal investigation is possible.[3,4] In resource-constrained settings, however, the challenge of simultaneously triaging high volumes of acutely ill children without laboratory support or sufficient trained intensivists necessitates robust, clinically grounded risk stratification tools.

Several paediatric severity scoring systems — including PRISM, PIM, and PEWS — have been developed to quantify illness severity, predict mortality, and guide escalation of care. However, these instruments typically rely on laboratory data, invasive monitoring parameters, or prolonged data collection windows, rendering them impractical for immediate first-contact triage.[5,6] Simpler bedside tools such as TOPRS address some of these limitations but are primarily calibrated for mortality prediction rather than level-of-care decision-making.

The signs of inflammation in children that kill (SICK) score represents a pragmatic advancement in this domain. Developed to estimate mortality risk at the time of first clinical contact using entirely observable physiological parameters — including heart rate, respiratory rate, systolic blood pressure, temperature, oxygen saturation, capillary refill time, and level of consciousness — the score can be calculated within minutes without laboratory support.[7,8] Risk stratification thresholds (score ≤2: low-to-moderate risk; >2: high risk; ≥3: very high risk) have been defined to guide triage and escalation decisions. Validation studies have demonstrated its discriminatory performance for mortality prediction across diverse geographical and resource settings, with AUC values ranging from 0.76 to 0.94.[7-9]

Despite this evidence, data evaluating the SICK score specifically for the clinically crucial decision of ward versus PICU-level care allocation — rather than mortality alone — remain limited. Similarly, its relationship with total hospital length of stay (LOS), a practical indicator of resource utilization and recovery trajectory, has not been comprehensively characterized. This prospective observational study was therefore designed to evaluate the efficacy of the SICK score in predicting the need for PICU admission versus general ward management among paediatric patients presenting to the emergency department of a tertiary care centre in Kerala, and to quantify its correlation with length of hospital stay as a secondary outcome.

METHODS

Study design and setting

A prospective observational study was conducted in the paediatric emergency department of Pushpagiri Institute of Medical Sciences and Research Centre, Thiruvalla, a tertiary referral institution in South Central Kerala. The study period extended over 18 months following receipt of Institutional Ethics Committee clearance.

Participants

All children aged 1 month to 12 years presenting consecutively to the paediatric emergency department during the study period were collected. Children were excluded if they left against medical advice, were primarily admitted to or transferred to the surgical side for operative interventions, or died in the emergency room before admission. Consecutive sampling was employed until the minimum required sample size was achieved.

Sample size

Sample size was calculated based on a sensitivity of 73.53% for SICK score ≥2 in predicting PICU admission, as reported by Thangaraj et al using the formula given.[10]

$$n = Z\alpha^2 \times Sensitivity \times (1 - Sensitivity)/(d^2 \times P)$$

Where Zα=1.96, d=15%, and P (proportion of ICU admissions) =10%, yielding a minimum sample size of 340 participants (including approximately 34 PICU admissions).

Scoring and data collection

The SICK score was calculated for each child at the time of presentation to the emergency department using a standardised proforma. The score incorporates seven physiological components — heart rate, respiratory rate, systolic blood pressure, body temperature, oxygen saturation, capillary refill time, and level of consciousness— each scored as normal (0) or abnormal (1) according to age-specific thresholds, with additional weighting for younger age. Following clinical assessment and SICK score calculation, children were admitted to either the general paediatric ward or the PICU at the discretion of the attending clinician. Length of hospital stay (LOS), measured in calendar days from admission to discharge, was recorded as the secondary outcome.

Statistical analysis

All data were entered in Microsoft Excel and analysed using IBM statistical package for the social sciences (SPSS) statistics (version 20.0). Continuous variables are presented as mean±standard deviation; categorical variables as frequency and percentage. Association between continuous variables and outcome groups was assessed using the independent samples t-test. Association between categorical variables and outcome was evaluated by Pearson Chi-square test. Pearson correlation coefficient was computed for the relationship between SICK score and LOS. ROC curve analysis was performed to determine the discriminatory ability of the SICK score for PICU admission; the area under the curve (AUC), 95%

confidence interval, optimal cut-off (determined by Youden's index), and corresponding sensitivity and specificity were reported. Statistical significance was defined as p<0.05.

RESULTS

Baseline clinical characteristics

A total of 340 children were enrolled, comprising 165 males (48.5%) and 175 females (51.5%). The mean age of the cohort was 70.46±41.76 months (range: 1–144 months) formed the study group. The overall mean SICK score was 2.93±2.22 (range: 0–7). Respiratory illnesses constituted the most common primary diagnosis (146 cases, 42.9%), followed by infections (75 cases, 22.1%), gastrointestinal conditions (58 cases, 17.1%), CNS disorders (43 cases, 12.6%), genitourinary conditions (10 cases, 2.9%), and accidents/poisoning (8 cases, 2.4%), as illustrated in Table 1.

Table 1: Baseline demographic and clinical characteristics of the study cohort (n=340).

Variable	Category/statistic	Value, N (%)
Total enrolled	N	340
Gender	Male	165 (48.5)
	Female	175 (51.5)
Age (months)	Mean±SD	70.46±41.76
	Range	1–144 months
Overall SICK score	Mean±SD	2.93±2.22
	Range	0–7
Length of stay (days)	Mean±SD	3.38±2.52
	Range	1–15 days
Primary diagnosis	Respiratory	146 (42.9)
	Infections	75 (22.1)
	Gastrointestinal	58 (17.1)
	CNS	43 (12.6)
	Genitourinary	10 (2.9)
	Accident/poisoning	8 (2.4)

Outcome distribution

Of 340 children, 300 (88.2%) were managed in the general paediatric ward and 40 (11.8%) required PICU admission. The outcome distribution is depicted in Figure 1.

Association between age, gender, and outcome

Children who required PICU admission were significantly younger (mean age 43.8±38.62 months) compared admitted in the ward (mean age 74.0±40.93 months; p<0.001), indicating that younger children faced higher illness severity necessitating intensive care. In contrast, gender distribution did not significantly differ between the ward and PICU groups (12.7% versus 10.9% PICU admission rate among males and females respectively; p=0.593).

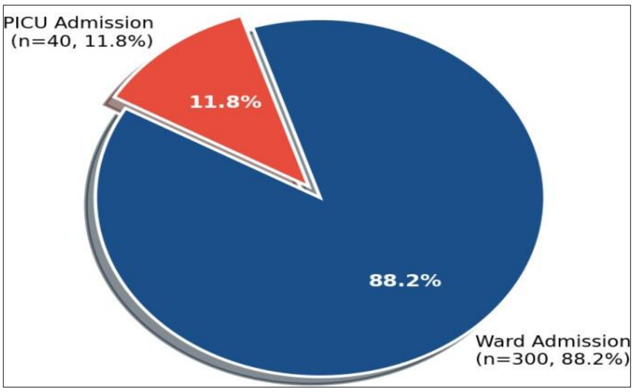

Figure 1: Distribution of clinical outcomes — ward versus PICU admission (n=340).

Table 2: Association between age, gender and clinical outcome.

Variable	Ward (n=300), N (%)	PICU (n=40), N (%)	P value
Age (months) mean±SD	74.0±40.93	43.8±38.62	<0.001*
Male	144 (87.3)	21 (12.7)	0.593†
Female	156 (89.1)	19 (10.9)	

*Independent t-test, †Chi-square test

SICK score association with outcome and length of stay

The mean SICK score was significantly higher among PICU-admitted children (5.23±1.687) compared to those managed in the ward (2.62±2.105; p<0.001), confirming a strong association between SICK score severity and requirement for intensive care. PICU patients also had a markedly longer mean hospital stay of 9.13±2.613 days versus 2.62±1.146 days in the ward group (p<0.001). A moderate positive correlation was observed between SICK score and total length of hospital stay across all 340 participants (Pearson r=0.324; p<0.001), indicating that higher SICK scores at presentation were associated with longer hospitalizations (Table 3 and Figure 2).

Table 3: Association between SICK score, length of stay and outcome group.

Variable	Ward (n=300)	PICU (n=40)	P value
Mean SICK score±SD	2.62±2.105	5.23±1.687	<0.001
Mean length of stay (days)±SD	2.62±1.146	9.13±2.613	<0.001
Correlation: SICK score versus LOS	Pearson r=0.324	p<0.001	—

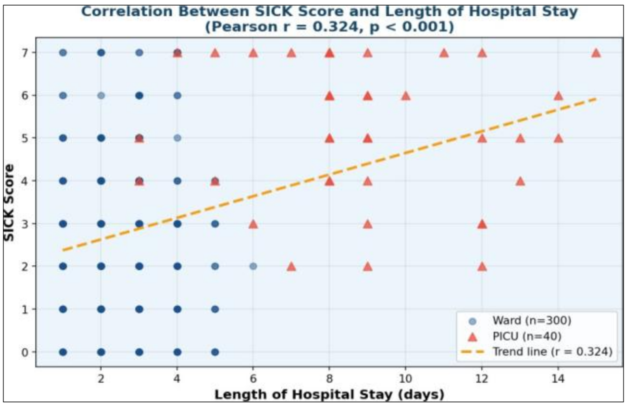

Figure 2: Scatter plot demonstrating positive correlation between SICK score and length of hospital stay (Pearson r=0.324, p<0.001).

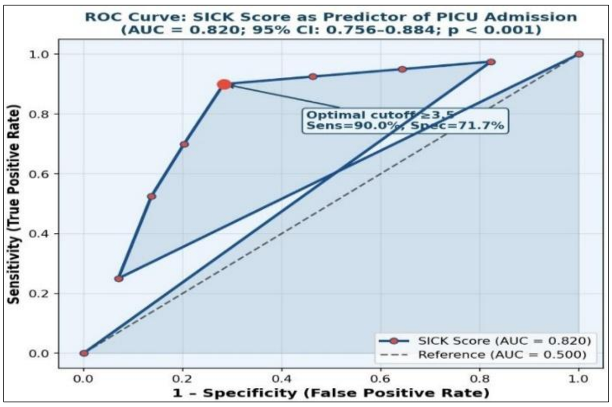

Figure 3: ROC curve for SICK score as predictor of PICU admission (AUC=0.820; 95% CI: 0.756–0.884; optimal cut-off ≥3.5).

ROC curve analysis

ROC curve analysis was performed to determine the optimal cut-off SICK score for predicting PICU admission. The AUC was 0.820 (standard error 0.033; 95% CI: 0.756–0.884; p<0.001), indicating good discriminatory ability substantially exceeding chance. Youden's index identified a cut-off of ≥3.5 as the optimal threshold, yielding a sensitivity of 90.0% and a specificity of 71.7%, with a Youden's index of 0.617 (Tables 4 and 5 and Figure 3).

Table 4: ROC curve analysis — SICK score as predictor of PICU admission.

Parameter	Value
AUC	0.820
Standard error	0.033
95% confidence interval	0.756–0.884
P value	<0.001
Optimal cut-off score	≥3.5
Sensitivity at optimal cut-off	90.0%
Specificity at optimal cut-off	71.7%
Youden's index	0.617

Table 5: Selected ROC curve coordinates at key SICK score thresholds.

Cut-off (SICK score ≥)	Sensiti-vity	Specificity (1-1-spec)	Clinical implication
0.5	97.5%	17.7%	Highly sensitive, low specificity
1.5	95.0%	35.7%	High sensitivity
2.5	92.5%	53.7%	Balanced sensitivity/ specificity
3.5*	90.0%	71.7%	Optimal threshold (Youden)
4.5	70.0%	79.7%	Increasing specificity

*Optimal cut-off identified by Youden's index

DISCUSSION

Primary findings

This prospective observational study demonstrates that the SICK score possesses robust discriminatory ability for predicting the requirement for PICU-level care among paediatric patients presenting to a tertiary emergency department in Kerala. The AUC of 0.820 (95% CI: 0.756–0.884) confirms good performance substantially exceeding random chance, and the optimal cut-off of ≥3.5 — with 90.0% sensitivity and 71.7% specificity — offers a clinically practical threshold for triggering PICU consultation and escalation of care. The statistically significant difference in mean SICK scores between ward (2.62±2.11) and PICU-admitted (5.23±1.69) groups (p<0.001) confirms that the score accurately captures the gradient of physiological severity across these distinct levels of care. The finding that PICU patients were significantly younger (43.8 versus 74.0 months; p<0.001) aligns with established epidemiological evidence that younger children face disproportionately higher physiological vulnerability to critical illness.[1,2]

Comparison with existing evidence

The AUC of 0.820 observed in this study aligns closely with the original prospective validation by Gupta et al, who reported AUC values of 0.848 in Delhi and 0.810 in London across a combined cohort of 5,368 children, demonstrating the geographical consistency of the SICK score's discriminatory performance.[7] Rajeshwari et al reported a higher AUC of 0.94 with an optimal cut-off of 2.5 for predicting mortality in 369 children; the higher threshold observed in the present study (≥3.5) is clinically consistent, as a greater degree of physiological derangement is required to predict PICU admission than mortality, the latter being a more extreme outcome.[8] Thangaraj et al reported an AUC of 0.691 in 531 children and demonstrated that a score ≥2 was associated with an odds ratio of 11.42 for PICU admission.[10] The present study's superior AUC may reflect differences in patient case-mix and disease acuity, with a higher proportion of moderately ill children in the Thangaraj cohort.

The meta-analysis by Deborah et al across 67 unique predictive models and 1.5 million children identified the SICK score as the best-performing individual model in the emergency department setting, with pooled sensitivity of 90–95% and specificity of 85–90% — closely mirroring the 90.0% sensitivity achieved at our optimal cut-off of ≥3.5.[11] Bhal et al demonstrated that the SICK score achieved an AUC comparable to PRISM (0.76 versus 0.78) in 125 paediatric patients, establishing parity between this simple bedside tool and a complex laboratory-based mortality score.[12] Our AUC of 0.820, derived without any laboratory data, further substantiates this equivalence and supports the clinical adoption of SICK as a practical alternative to resource- intensive scoring systems.

SICK score and length of hospital stay

The moderate positive correlation between SICK score and length of hospital stay (r=0.324; p<0.001) constitutes a clinically meaningful finding with direct implications for resource planning and parental counselling. Pallithanam et al similarly reported a significant positive correlation between SICK score and duration of hospital stay in both ward and PICU settings, with mean scores of 5.828±1.069 among non-survivors versus 3.798±1.003 in survivors — the survivor mean closely approximating the optimal cut-off of 3.5 identified in the present study.[13] Thangaraj et al reported a mean difference of 45.58 hours in hospital stay between higher and lower SICK score groups, providing parallel evidence that the score functions as a proxy for resource utilisation intensity.[10] These findings collectively indicate that the SICK score at presentation can inform not only the immediate level-of-care decision but also prognosis for recovery trajectory and anticipated hospitalization duration.

Clinical and contextual implications

In the Indian emergency care context, characterized by high patient volumes, delayed presentations, limited intensivist availability, and resource constraints, the SICK score's non-invasive, laboratory-independent design confers substantial practical advantages. The validated cut-off of ≥3.5 identified in this study provides an objective, immediately applicable trigger for PICU consultation, representing a significant improvement over subjective clinical gestalt in high-pressure triage environments.

Comparisons with TOPRS by Ganda et al and the Bains model further support the paradigm that standardised bedside physiological scoring — even using different variable combinations — consistently identifies high-risk children with sensitivities exceeding 90% at appropriate thresholds.[14,15] This convergence across tools reinforces the value of systematic physiological assessment at the point of first contact, irrespective of the specific scoring instrument employed.

Limitations

Several limitations warrant acknowledgement. The single-centre design limits generalizability to primary and secondary care settings with different patient demographics and admission thresholds. The relatively small number of PICU admissions (n=40, 11.8%) may reduce statistical precision for secondary analyses in this subgroup. The absence of a head-to-head comparison with established ICU severity scores such as PRISM or PIM limits assessment of relative discriminatory performance. Additionally, the SICK score does not account for chronic co-morbidities including congenital heart disease, malnutrition, or immunodeficiency, which may independently modify both score interpretation and clinical outcomes.

Future multicentre studies incorporating diagnostic confirmation, comparative scoring, and longitudinal outcome follow-up are required to strengthen the evidence base for SICK-guided triage protocols.

CONCLUSION

This prospective observational study of 340 paediatric emergency patients establishes the SICK score as a highly effective bedside triage instrument with good discriminatory ability for predicting PICU admission (AUC=0.820; 95% CI: 0.756–0.884). The identified optimal cut-off of ≥3.5 provides 90.0% sensitivity and 71.7% specificity, offering a clinically practical, evidence-based threshold for escalation of care. The significant positive correlation between SICK score and length of hospital stay (r=0.324; p<0.001) further demonstrates its value as a prognostic instrument for resource allocation and clinical communication. Younger age was a significant independent predictor of PICU requirement, while gender showed no significant association with outcome.

The SICK score's reliance on observable, non-invasive physiological parameters, its rapid calculability at the bedside, and its demonstrated predictive performance across diverse clinical settings collectively support its integration into standardized paediatric emergency department triage protocols. This is of particular importance in high-volume, resource-constrained environments such as those prevalent in South Asian tertiary care hospitals, where laboratory data may be delayed and early objective risk stratification can meaningfully reduce preventable deterioration and mortality. Multicentre validation, longitudinal outcome studies, and health- economic evaluation of SICK-guided triage implementation represent priority areas for future research.

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