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Pediatric simple triage score: A simplified approach for triaging pediatric patients with fever in the emergency department

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Abstract:

INTRODUCTION: The initial 24-h period following admission to a hospital holds profound significance for pediatric patients, representing a critical window where proactive interventions can substantially influence outcomes. We devised a simple triage system, pediatric simple triage score (PSTS), to see whether rapid triage of sick pediatric patients with fever can be done using the new triage system in the emergency department (ED) to predict hospital admission.

METHODS: This was a prospective observational study, conducted at the department of emergency medicine of a tertiary care teaching hospital in southern India. A prospective cohort of children presenting to the ED underwent assessment for temperature, oxygen saturation (SpO2), pulse rate, respiratory rate, sensorium, and hydration status. Sensorium was evaluated based on criteria such as poor cry, poor feeding, or decreased activity, while hydration status was assessed using indicators such as decreased urine output, dry mucous membranes, or reduced skin turgor. Subsequently, participants were triaged according to the National Institute for Health and Care Excellence (NICE) guidelines. We then monitored the admission outcomes, whether they were admitted to the intensive care unit (ICU), the ward, or discharged, based on clinical decisions made by the pediatric consultant.

RESULTS: In this study involving 350 participants, the mean age was found to be 2.72 years (standard deviation [SD] ±1.78), with a range from 29 days to 5 years. The study population consisted of 60.86% males with a total of 213 patients. Examining vital signs, the mean heart rate was 135.07 beats/min (SD ± 21.58), with a range of 82–200 beats/min. The mean temperature was 37.57°C (SD ± 0.52), with values ranging from 36.80°C to 39.20°C. The mean respiratory rate was 36.28 breaths/min (SD ± 14.06), varying from 20 to 90 breaths/min. SpO2 averaged at 96.31% (SD ± 3.64), with values ranging between 70% and 100%. Abnormal sensorium was observed in 10.86% of the participants, while seizures were reported in 2.57%. Dehydration was present in 3.71% of the study population. Among the study participants, 24.57% were admitted to the ICU, 30.57% to the ward, and 44.86% were treated as outpatients. According to PSTS, 192 (54.86%) participants were triaged to green, 119 (34%) participants to yellow, and 39 (11.14%) participants to red. The PSTS demonstrated a sensitivity of 59.59% and a specificity of 72.61% in predicting hospital admission. The NICE triage system had a sensitivity of 80.31%, in predicting the admission (either ward/ICU), with a specificity of 72.61%.

CONCLUSION: The PSTS demonstrated fair agreement with the NICE; it exhibited lower sensitivity and positive predictive value. However, the simplicity of the new system renders it potentially useful, especially in resource-limited settings.

Keywords:
Emergency department, fever, pediatric, triage

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Box-ED section

What is already known about the study topic?

- Swift identification and immediate treatment of critically ill children on their arrival at healthcare facilities can reduce mortality
- Triaging tools should possess robust predictive capabilities concerning clinical outcomes and resource utilization.

What is the conflict on the issue? Is it important for readers?

- Complexity and reliance on extensive data collection pose practical challenges, demanding substantial physician input and sophisticated methodology in many triaging systems
- Rapid triaging can ensure timely intervention by pediatricians.

How is this study structured?

- This was a single-center, prospective observational study of 350 pediatric patients.

What does the study tell us?

- The high specificity of pediatric simple triage score renders it a simple tool accessible to any healthcare personnel.

Introduction

The initial 24-h period following admission to a hospital holds profound significance for pediatric patients, representing a critical window where proactive interventions can substantially influence outcomes. Swift identification and immediate treatment of critically ill children on their arrival at healthcare facilities stand as pivotal measures in preventing premature pediatric deaths.[1] Central to this approach is the concept of rapid triage, which spans the continuum of care, extending from prehospitalization to emergency department (ED) and pediatric wards.[2] Triage serves a paramount goal: ensuring precise care, delivered at the right time, and in the appropriate setting.[3] The efficacy of triage tools hinges on their ability to swiftly adapt to a patient's changing condition while maintaining attributes of speed, validity, and reproducibility.[4] Moreover, these tools should possess robust predictive capabilities concerning clinical outcomes and resource utilization. Classifying triage systems based on physiological, anatomical, or mixed data, alongside injury mechanisms, further elucidates their effectiveness.[5] However, the efficacy of these systems depends on their ability to strike a delicate balance between sensitivity and specificity. Overtriage escalates the workload and diverts essential medical resources, stretching the core capacities of an ED, whereas undertriage results in prolonged wait times, delays in diagnosis and treatment, and an overall inadequate level of care provision. Recognizing these challenges, the World Health Organization established guidelines and training materials in 2016, specifically tailored for low-resource settings. These guidelines outline emergency signs necessitating immediate attention, including but not limited to obstructed or absent breathing, severe respiratory distress, central cyanosis, signs of shock, coma, seizures, and indicators of severe dehydration in children with diarrhea.[1]

The absence of an ideal tool capable of identifying all danger signs with high sensitivity and simplicity underscores the necessity for precision in triage systems.[6,7] Particularly in developing countries like India, where public medical insurance systems are in their infancy, identifying and prioritizing seriously ill pediatric patients in emergency settings is crucial for both clinical outcomes and addressing parental concerns regarding hospitalization, treatment costs, and prognosis.[8,9] Existing scoring systems primarily developed for intensive care unit (ICU) patients and neonates have limited applicability during admission, rendering them unsuitable for triage purposes.[10] This inadequacy has prompted efforts to devise triage scales specifically tailored for low-resource settings in low- and middle-income countries (LMICs), as demonstrated by tools like the Pediatric South African Triage Scale, the WHO Emergency Triage Assessment and Treatment, and the temperature oxygen saturation (SpO2) pulse rate respiratory rate seizure and sensorium (TOPRS) score.[11]

One notable system, the National Institute for Health and Care Excellence (NICE) traffic light system, caters to children under 5 years of age across various healthcare settings. However, its complexity and reliance on extensive data collection pose practical challenges, demanding substantial physician input and sophisticated methodology. Hence, this study endeavors to introduce a streamlined triaging scoring system, pediatric simple triage score (PSTS) specifically for children <5 years with fever, using basic physiological parameters, and subsequently compare its efficacy with the established NICE traffic light system. The necessity arises from the evolving nature of children's physiology, especially in cases involving fever without an apparent source, where distinguishing between benign viral illnesses and life-threatening bacterial infections remains challenging.[12] Hence, we devised a simple triage system, PSTS, to see whether rapid triage of sick pediatric patients with fever can be done using the new triage system in the ED to predict hospital admission.

Objectives

The objectives of the study were to study the utility of a simple scoring system to be used in the pediatric ED to triage patients with fever and compare it with the existing NICE traffic system.

Methods

Study design and setting

This study was conducted at the ED of ASTER MIMS, situated in Kozhikode, Kerala. This was a prospective observational study.

Selection of participants

The study population consisted of children aged 28 days to 5 years presenting to the ED with a history of fever. Data collection took place from October 30, 2016, to October 29, 2017, spanning a period of 1 year. Pediatric patients under the age of five, presenting to the ED with a history of fever, and either a recorded high temperature from the ED or from a referral hospital were included in the study. Children transported by mobile ICU, infants younger than 28 days of age, children older than 5 years, those with trauma, and those lacking fever were excluded from the study.

Sample size calculation

The sample size was determined based on the expected proportion of children admitted (7.2%) and the sensitivity and specificity of the NICE triaging method. Sensitivity and specificity were estimated at 85.8% and 28.5%, respectively.[12] The sample size was calculated using formulas proposed by Buderer *et al*.,[13] resulting in a requirement of 334 subjects for sensitivity and 339 subjects for specificity. To account for a loss to follow-up of approximately 5%, an additional 15 subjects were planned, leading to a final sample size of 354. A total of 350 subjects were included in the final analysis after excluding loss to follow-up.

Methodology

A prospective cohort of children presenting to the ED underwent assessment for temperature, SpO2, pulse rate, respiratory rate, sensorium, and hydration status. Sensorium was evaluated based on criteria such as poor cry, poor feeding, or decreased activity, whereas hydration status was assessed using indicators such as decreased urine output, dry mucous membranes, or reduced skin turgor. Subsequently, participants were triaged according to the NICE guidelines, and triage categories were documented. We then monitored the admission outcomes, whether they were admitted to the ICU, the ward, or discharged, based on clinical decisions made by the pediatric consultant.

Scores in the PSTS were assigned based on abnormal ranges according to standard systemic inflammatory response syndrome criteria and advanced pediatric life support guidelines. The study by Bains and Soni using the TOPRS score which included clinical parameters demonstrated more than 60% mortality when the score was more than four. Based on the TOPRS score, with the addition of hydration status, a scoring system was devised in our ED with scores of ≥4 indicating a RED triage category, scores of 2–3 indicating a YELLOW triage category, and scores of 0–1 indicating a GREEN triage category [Table 1]. The PSTS assessments were conducted without the admitting physician's knowledge. Written consent was taken from the guardian before including the patients in the study.

Statistical methods

Descriptive analysis was conducted using means, standard deviations (SDs), frequencies, and proportions. The association between triage outcomes was assessed using cross-tabulation and Chi-square tests. Sensitivity, specificity, predictive values, and diagnostic accuracy of the screening test were calculated, along with kappa statistics for reliability assessment. Statistical significance was set at $P < 0.05$ using IBM SPSS Statistics for Windows, Version 22.0. Armonk, NewYork: IBM Corp.

Ethical considerations

The study protocol was approved by the institutional human ethics committee (Institutional Ethics Committee Malabar Institute of Medical Sciences Ltd.) and the corresponding number is "IEC Reg. No. ECR/301/inst/KL/2013" dated: June 20, 2017. Informed written consent was obtained from all study participants or their legal guardians. Participants were briefed about the study's risks, benefits, and voluntary nature before consenting. Confidentiality of participant information was strictly maintained.

Results

In this study involving 350 participants, the mean age was found to be 2.72 years (SD ± 1.78), with a range from 29 days to 5 years. The study population consisted of 60.86% males with a total of 213 patients. Examining vital signs, 152 patients (43.4%) had tachycardia and the

Table 1: Pediatric simple triage score variables

Variables	Abnormal range
Temperature (°C)	>38 or<36
Pulse rate (beats per min)	Age<12 months - >160 Age 12–24 months - >150 Age 2–5 years - >140
Respiratory rate (breaths per min)	0–6 months - >60 6–24 months - >50>24 months - >40
Oxygen saturation (%)	<94
Sensorium	Decreased activity, poor feeding, and poor cry
Seizures	Present
Hydration status	Dehydrated

Normal: 0 score, Abnormal: 1 score

mean heart rate was 135.07 beats/min (SD ± 21.58), with a range of 82–200 beats/min. The mean temperature was 37.57°C (SD ± 0.52), with 140 patients (40%) having recorded high temperatures. The mean respiratory rate was 36.28 breaths/min (SD ± 14.06), with 98 patients (28%) having tachypnea for age at presentation to the ED. SpO2 averaged at 96.31% (SD ± 3.64), with 48 patients (13.7%) having desaturation <94% [Table 2].

In terms of clinical conditions, abnormal sensorium was observed in 10.86% of the participants, whereas seizures were reported in 2.57%. Dehydration was present in 3.71% of the study population [Table 3]. Among the study population, triaged according to the NICE, 152 (43.43%) participants were green, 128 (36.57%) participants were yellow, and 70 (20%) participants were red. According to PSTS, 192 (54.86%) participants were triaged to green, 119 (34%) participants to yellow, and 39 (11.14%) participants to red. Among the study participants, 24.57% were admitted to the ICU, 30.57% to the ward, and 44.86% were treated as outpatients [Table 4]. The comparison between the NICE triage system and PSTS indicated a moderate level of agreement in patient admission, with a Kappa value of 0.543 ($P < 0.001$). The PSTS demonstrated a sensitivity of 59.59% and a specificity of 72.61% in predicting hospital admission, whereas the NICE triage system had a sensitivity of 80.31%, in predicting the admission (either ward/ICU), with a specificity of 72.61% [Table 5].

Discussion

Triage, a cornerstone of emergency health care, prioritizes patients based on the severity of their condition to ensure timely and appropriate treatment.[14] While triage protocols are invaluable in expediting care, pediatric triage presents unique challenges due to children's diverse physiology, developmental stages, communication limitations, and reduced cooperation.[15]

In a study by Bains and Soni involving 777 pediatric ED (PED) attendees, temperature, SpO2, and respiratory rate emerged as significant predictors of mortality. The incidence of mortality escalated with an increasing number of abnormal variables, underscoring the prognostic value of these vital signs. Moreover, patients with two or more abnormal variables were deemed at heightened risk in emergency triage scenarios.[6] In our study, 12 green patients were admitted to ICU and all these patients had a low SpO2 on ED arrival. Patients having low SpO2 can be an independent variable in predicting the severity of the illness and patients requiring ICU admission.

Similarly, Kumar *et al*., in a study of 1099 PED attendees, identified two or more abnormal clinical variables as indicative of serious illness with potentially fatal outcomes.[16] Notably, variables such as seizure and hydration status were not considered, with systolic blood pressure and capillary refill time included instead. Our study also showed a score of more than two requires admission and treatment.

In a study by Thompson *et al*. concerning children with serious infections, it was determined that a combination of vital signs could effectively distinguish between children with severe and less severe infections within a pediatric assessment unit.[17] This parallels our investigation, wherein we utilized a combination of vital signs to assess the disposition of febrile children, whether for admission or discharge. Most of the patients when presented to the ED were afebrile because these patients received antipyretics from the referring hospital.

Our study yielded a sensitivity of 59.59%, a specificity of 72.61%, and a positive predictive value of 72.78% when utilizing the PSTS for hospital admission assessment. Whereas, in our study, the NICE guidelines for identifying serious illness necessitating hospital admission in febrile children demonstrated a sensitivity of 80.31% and a specificity of 72.61%. Despite the superior sensitivity and specificity demonstrated by NICE guidelines, the high specificity of PSTS renders it a simple tool accessible to any healthcare personnel, including untrained nursing staff. This simplicity facilitates the prompt identification of children necessitating admission, prompting immediate consultation or referral in resource-limited settings. In a two-center study conducted by Gupta *et al*., spanning both India and England, the severity of illness was assessed utilizing the Signs of Inflammation in Children that can Kill score. The predictive capacity of this score was determined to be 84.1%, exhibiting a sensitivity of 79.6% and specificity of 74.4%.[18] Conversely, Seiger *et al*. evaluated the pediatric early warning score across

Table 2: Analysis of vital parameters used in pediatric simple triage score

Parameters	Mean±SD	Minimum	Maximum	95% CI	
				Lower	Upper
HR (per min)	135.07±21.58	82.00	200.00	132.80	137.33
Temperature (°C)	37.57±0.52	36.80	39.20	37.52	37.63
RR (per min)	36.28±14.06	20.00	90.00	34.80	37.76
SpO2 (%)	96.31±3.64	70	100	95.93	96.70

CI: Confidence interval, HR: Heart rate, RR: Respiratory rate, SpO2: Oxygen saturation, SD: Standard deviation ten distinct studies. Their analysis revealed that the area under the receiver operating characteristic curves for predicting hospitalization ranged from poor to moderate, spanning values between 0.56 and 0.68.[19]

In our study, the area under the ROC curve for the PSTS in predicting hospital admission was found to be 0.66 [Figure 1] and for NICE triage was 0.81 [Figure 2]. This metric denotes the discriminatory power of PSTS in accurately predicting the need for hospitalization among pediatric patients. These findings underscore the importance of robust assessment tools in pediatric emergency care, facilitating prompt and accurate identification of patients requiring heightened medical intervention.

Vital signs' measurement is considered standard practice in pediatric ED triage assessment. This PSTS is simple and does not require any special training or sophisticated investigation and can be applied immediately on patients even in resource-poor settings. This is much helpful in the middle- and low-income country scenario, where the majority of the emergency cases are reported in primary care centers. Further studies in PSTS can add to our research in optimizing clinical decision-making processes and ultimately improving patient outcomes.

Limitations

The main limitation of the study is that it primarily focused on hospital admission as the primary outcome measure. However, other relevant end points such as morbidity and mortality outcomes were not

Table 3: Analysis of variables used in pediatric simple triage score

Parameters	Present (%)	Absent (%)
Tachycardia (for age)	152 (43.4)	198 (56.6)
Tachypnea (for age)	98 (28)	252 (72)
Temperature	140 (40)	210 (60)
SpO2 (<94%)	48 (13.7)	302 (86.3)
Seizure	9 (2.57)	341 (97.43)
Altered sensorium	38 (10.86)	312 (89.14)
Dehydration	13 (3.71)	337 (96.29)

SpO2: Oxygen saturation

Table 4: Comparison of triaged according to the National Institute for Health and Care Excellence and pediatric simple triage score with admission status (*n*=350)

	Admission status		
	ICU, *n* (%)	Ward, *n* (%)	OP, *n* (%)
Triaged according to NICE			
Green (*n*=152)	0	38 (25)	114 (75)
Red (*n*=70)	70 (100)	0	0
Yellow (*n*=128)	16 (12.5)	69 (53.9)	43 (33.6)
Triaged according to PSTS			
Green (*n*=192)	12 (6.3)	66 (34.4)	114 (59.4)
Red (*n*=39)	39 (100)	0	0
Yellow (*n*=119)	35 (29.4)	41 (34.5)	43 (36.1)

ICU: Intensive care unit, OP: Outpatient, *n*: Number of patients, NICE: National Institute for Health and Care Excellence, PSTS: Pediatric simple triage score

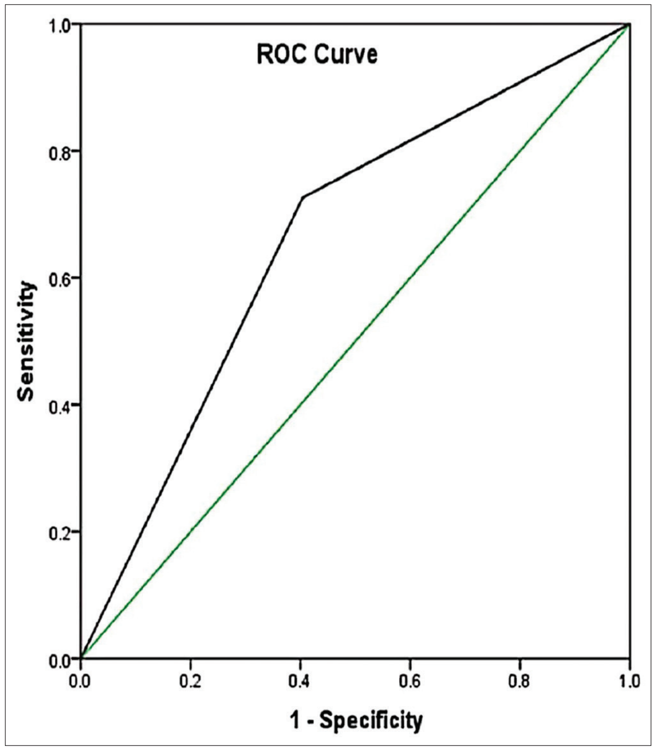

Figure 1: Receiver operating characteristic curve for the pediatric simple triage system in predicting hospital admission showing area under the curve − 0.66. ROC: Receiver operating characteristic

Table 5: Sensitivity, specificity, and diagnostic accuracy of pediatric simple triage system and National Institute for Health and Care Excellence triage in predicting admission

Parameters	PSTS triage	95% CI		NICE triage	95% CI	
	Value	Lower	Upper	Value	Lower	Upper
Sensitivity (%)	59.59	52.30	66.57	80.31	73.99	85.67
Specificity (%)	72.61	64.93	79.42	72.61	64.93	79.42
Positive predictive value (%)	72.78	65.14	79.55	78.28	71.88	83.81
Negative predictive value (%)	59.38	52.07	66.39	75.00	67.34	81.66
Diagnostic accuracy (%)	65.43	60.19	70.40	76.86	72.08	81.17
Positive likelihood ratio	2.18	1.56	2.648	2.93	2.24	3.961
Negative likelihood ratio	0.56	0.07	0.677	0.27	0.02	0.366

CI: Confidence interval, NICE: National Institute for Health and Care Excellence, PSTS: Pediatric simple triage score

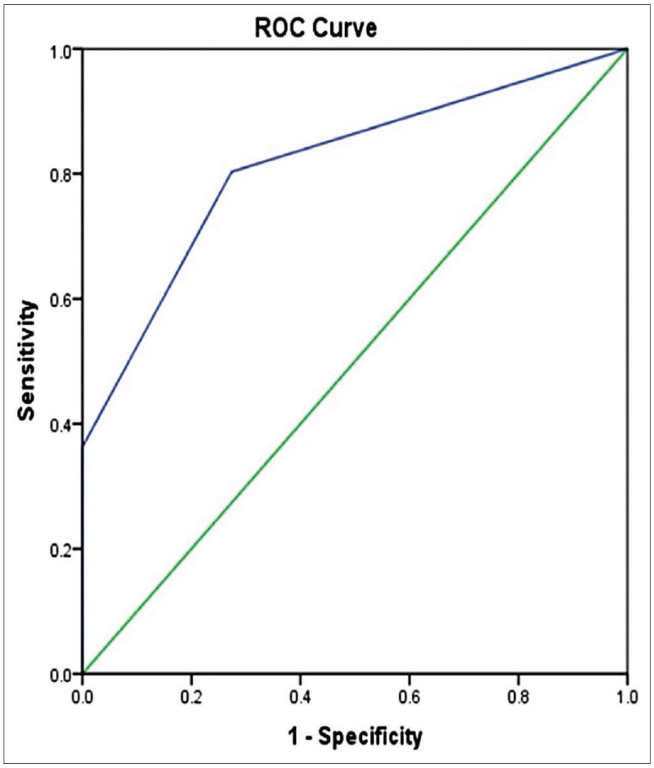

Figure 2: Receiver operating characteristic curve for the National Institute for Health and Care Excellence triage in predicting hospital admission showing area under the curve − 0.81. ROC: Receiver operating characteristic

systematically evaluated. Even though the pediatric consultants were not part of the study, there may be differences between the consultants regarding decisions related to admissions. Conducting the study within a single tertiary healthcare facility may limit the generalizability of our findings to other healthcare settings with different patient populations, resources, and care protocols. The study may have been limited by its sample size and geographic scope. The findings may not be broadly applicable to diverse populations or healthcare settings beyond the specific context of our study.

Conclusion

Our study evaluated a simplified triaging system in comparison to the NICE triage system for predicting admission in children under 5 years of age. While the PSTS demonstrated fair agreement with NICE, it exhibited lower sensitivity and positive predictive value. Notably, the NICE system showed higher sensitivity, specificity, and positive predictive value. However, the simplicity of the new system renders it potentially useful, especially in resource-limited settings. While the PSTS demonstrated moderate predictive ability, further validation studies are necessary to assess its reliability, reproducibility, and applicability across different healthcare contexts.

Author contribution statement

AAV: Conceptualization (lead); Methodology (lead); Software and investigation (lead); Formal Analysis; Writing - original draft (lead); Project administration. VP: Methodology (lead); Investigation (support); Data Curation; Writing - original draft (lead); Supervision, Visualization, Writing - review and editing; RTS: Writing - original draft (support); Supervision, Writing - review and editing; IMS: Software and investigation (support); Visualization; Resources (support); Writing - original draft (lead); Writing - review and editing. RP: Writing - original draft (support); Supervision, Writing - review and editing; AKJ: Writing - original draft (support); Supervision, Writing - review and editing; RPK: Writing - original draft (support); Supervision, Writing - review and editing; NS: Writing - original draft (support); Supervision, Writing - review and editing; AAV did the overall supervision of the whole study and all authors made a substantial contribution. All authors have read and agreed to the content of the final manuscript. [AAV: Arshad Ali Vadakkeveedan, VP: Venugopalan Poovathumparambil, RTS: Rohan Thomas Senapathy IMS: Ijas Muhammed Shaji, RP: Ridha Padiyath, AKJ: Ajith Kumar Jayachandran, RPK: Roshan P Kunheenkutty, NS: Nadeer Savad].

Conflicts of interest

None Declared.

Ethical approval

The study has been approved by the Institutional Ethics Committee Malabar Institute of Medical Sciences Ltd. (MIMS) and the corresponding number is “IEC Reg. No. ECR/301/inst/KL/2013” dated: June 20, 2017.

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