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**Original Research Article**

# Evaluation of CABS score based on vitals in children at admission for prediction of severity of illness and outcome

**Aparajitha Mekala[1], Barathy Chandrasegaran[2], N. Shivaramakrishna Babji[3]*, Vellamki Brahma Kumar[3]**

[1]Department of Paediatrics, Chettinad Health and Research center, Kelambakam, Chennai, India
[2]Department of Paediatrics, Indira Gandhi Medical College and Research Institute, Puducherry, India
[3]Department of Paediatrics, Mamata Medical College, Khammam, Telangana, India

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***Correspondence:**
Dr. Shivaramakrishna Babji N.,
E-mail: shivababji123@gmail.com



## ABSTRACT

**Background:** Triage in an emergency is sorting out the patients based on the severity of illness and prioritizing care accordingly. Kumar et al devised a score taking temperature, heart rate, respiratory rate, blood pressure, capillary refill time, oxygen saturation, and sensorium. We propose to evaluate a sickness scoring system based on capillary refill time, sensorium using AVPU score, blood pressure, and oxygen saturation by pulse oximetry (CABS) which are least affected by stress, anxiety, temperature, acidosis, etc.
**Methods:** Prospective study in children admitted consecutively in the age group one month to 12 years from 1st January 2019 to 31st December 2019, to paediatric intensive care unit**.** Triage score applied at the time of the first contact. Each variable in the study was scored as 0 for being normal and a score of 1 for being abnormal. The total score for each child is obtained. The outcome at discharge was correlated with the study variables and total score. ROC curve analysis was done for the overall predictive ability of the score.
**Results:** Of 346 children admitted, 27 expired, and 319 children were discharged. The risk of mortality increased with the increasing score. CFT, sensorium, blood pressure, and oxygen saturation are all significantly associated with mortality. A cut-off score of 2 has the highest sensitivity and specificity of 96.3% and 70.2%. The total score has 90% predictive accuracy as AUC is 0.913.
**Conclusions:** As no special training is required for its implementation, the score is promising as a triage tool in resource-poor settings.

**Keywords:** Triage, Scoring systems, Outcome, Mortality

## INTRODUCTION

In an emergency department, a large number of patients visit every day. In a crowded emergency department, consulting patients in the order of attending will lead to long waiting times, which may be detrimental for seriously ill patients.[1] Triage in an emergency is sorting out the patients based on the severity of illness and prioritizing care accordingly.[2] Triage can also be used to identify patients who need urgent care and who can safely wait.[3] The early identification of the severity of illness is especially important for prioritizing treatment to reduce morbidity and mortality[4]and allow proper utilization of limited resources in the developing world. Triage is done using a variety of parameters like clinical symptoms, signs, vitals, laboratory findings in various combinations.[5,6] Various scoring systems have been proposed to assess the severity of the illness, which can predict mortality.

The first scoring system, therapeutics intervention scoring system (TISS), is based on therapeutic intensity determining the severity of illness in paediatric intensive care.[7] Hence it is more useful in assessing the quality of care and expenditure than in initial triage.[7] The first physiology-based scoring system to determine the severity of acute illness in the total population of infants and children admitted to PICU was the physiologic stability index (PSI). It has a total of 34 measured variables from seven systems.[7]

The paediatric risk of mortality (PRISM) score was developed from PSI as a simplified version having 14 variables.

These existing scoring systems have physical and laboratory variables as their parameters and are difficult to apply for primary triage.[8] Studies were done on standard scoring systems like PRISM and PIM in various centres over the estimated risk of mortality.[9] A study done in the intensive care unit in South Africa has shown the PRISM's poor discriminatory performance at all age groups and diagnostic categories.[10] WHO developed the guidelines for emergency triage, assessment, and treatment (ETAT) of sick children requiring special training for both staff and doctors and reorganizing existing health care services.[11] Over triage by the Manchester Triage System poses a problem as at-least 40% of children are classified in the urgency category, leading to overwhelming resources, making it unsuitable for use in resource-poor settings in developing countries.[12] A combination of the vital signs can be used to the differentiate children with severe infections from those with less serious infections in a paediatric assessment unit and has comparable sensitivity to more complicated triage systems.[13] Hence, accurate measurement of vital signs is a key step in the determination of the overall severity of the illness in triage in resource-poor settings.[14]

Hence there is a need for a scoring system that utilizes physical criteria alone and does not need special training for both staff and doctors. Kumar et al devised a triage score based on vitals, which are variables of SIRS (systemic inflammatory response syndrome) and its continuum.[8] He devised a score taking temperature, heart rate, respiratory rate, blood pressure, capillary refill time, oxygen saturation by pulse oximetry, and sensorium using AVPU score. He concluded that the presence of 2 or more abnormal variables should be taken seriously, which might lead to death. However, heart rate and respiratory rate as individual variables did not show a significant association with mortality, while the rest five variables showed a significant association. This score was further evaluated by Pranam and concluded that other than temperature, all other variables showed significant association with mortality.[15]

Tachycardia can be because of stress, fever, anxiety. An increase in temperature, stress, anxiety, acidosis can cause tachypnoea. We propose to evaluate a sickness scoring system based on capillary refill time, sensorium using AVPU score, blood pressure, and oxygen saturation by pulse oximetry (CABS) as they are least affected by stress, anxiety, temperature, acidosis, etc. Further, as individual variables, these four variables were found to have a significant association with outcome in this studies done by Kumar et al and Pranam et al. [8,15]

Such a scoring system will help in the identification of sick children in ED and will add to better management and outcome. Such a scoring system will also help in the proper utilization of limited sources, which is especially useful in developing countries.

### *Aims and objectives*

Aims and objectives of the study were 1) To evaluate triage scoring system based on capillary refill time, sensorium using AVPU score, blood pressure, and oxygen saturation by pulse oximetry (CABS). 2) To find the predictive value of the total score in assessing the outcome. 3) To find the association of each of these four individual variables with the outcome.

## METHODS

### *Study design*

This prospective study was done at Mamata general and Super specialty hospital Khammam. The hospital is a tertiary care center serving the health needs of 3 districts of Telangana. This being an affordable tertiary care hospital, people belonging to all socioeconomic strata visit here. This hospital being a tertiary care center, sick children, not only from Khammam but the people of adjoining districts, are referred here. Ethical consent was obtained for the study with an institutional ethical committee. All the children of both sexes were admitted to the PICU in the age group of more than one month up to 12 years from January 1st, 2019, to December 31st 2019 (12 months). The recording of the variables is part of the assessment of children admitted to our PICU. Consent was obtained from parents for participation.

A convenient sampling technique was used as the sampling technique. The sample size was considered as all the children admitted consecutively during this period in the paediatric intensive care unit. Children more than one month of age up to 12 years admitted in the paediatric intensive care unit were included in the study. Children with surgical problems and those discharged against medical advice or transferred to another hospital while undergoing treatment were excluded.

After admission in PICU following clinical examination at the first contact, a triage score was applied to each child. Triage score consisted of physical variables of CABS, namely capillary refill time, level of sensorium

(using AVPU score), blood pressure, and oxygen saturation by pulse oximetry.

Capillary refill time was measured by lifting the lower limb slightly above the heart level and applying pressure over the great toe for 5 seconds and then counting the time in seconds for a capillary refill. In the AVPU score, a child being alert is considered normal, and a score of 0 is given. Responsive to voice, pain, and the unresponsive to both is considered abnormal, and the same score of one is given to any of these three responses. The blood pressure is measured used a sphygmomanometer, using appropriate cuff size. Oxygen saturation by pulse oximetry is measured using the pulse oximeter Contec® CMS-50A.

**Table 1: Scoring of abnormal variables.**

| Vital signs | Abnormal |
|---|---|
| **Blood pressure (Systolic)** | <70 mmHg (<1 month to 1 year)<br><age×2+70 (1-10 years)<br><90 mmHg (>10 years) |
| **Capillary refill time** | ≥3 secs |
| **Pulse oximetry saturation** | <90% |
| **Sensorium level (AVPU score)** | Responsive to voice,<br>Responsive to pain,<br>Unresponsive |

Each variable in the study was scored as 0 for being normal and the score of 1 for being abnormal is shown in table.1, and a total score for each child is obtained on a predesigned proforma, which consisted of general demographic characteristics name, age, sex, chief complaints, positive clinical signs, diagnosis and the predominant system involved. These children were further followed up for the outcome, i.e., discharged or expired.

The outcome at discharge will be correlated with the study variables and the total score. ROC curve analysis will be performed to see the overall predictive ability of the score.

***Statistical analysis***

The collected data was coded, and statistical analysis was done using statistical package for social sciences (SPSS) software version 12. Descriptive statistics (frequency distribution and cross tabulation) were also used. A chi-square test was employed to evaluate the association between clinical outcome and the study variables, namely, age, sex, SBP, CFT, AVPU, $SpO_2$ and total score. Further, the association between total score and clinical outcome was evaluated in terms of odds ratio using logistic regression analysis. A ROC (receiver operating characteristic curve) analysis was used to assess the diagnostic accuracy of the total score and its ability and also to find the optimal cut off values. A p value of ≤0.05 was considered significant.

## RESULTS

Three hundred forty-six children admitted in intensive care unit were studied, out of which 27 expired, and 319 were discharged. Among the children aged less than five years, the proportion of children was 9.41% compared to only 4.9% among the children aged 5 to 12 years. But this finding was not statistically significant (p value of >0.05).

The mortality was highest in patients with multisystem involvement (87.5%), followed by CNS involvement (12.5%).

**Table 2: Distribution of total score by patient's discharge status.**

| Total score | Discharged | Expired | Odds ratio | 95% CI |
|---|---|---|---|---|
| **≤1** | 294 | 9 | 24.216 | 2.97-196.84 |
| **2** | 16 | 4 | 56.0 | 5.9-530.9 |
| **3** | 3 | 6 | 448.0 | 40.47-4958 |
| **4** | 2 | 8 | 896.0 | 73.4-10936 |
| **Total** | 319 (92.2%) | 27 (7.8%) | | |

P<0.001, Highly significant.

There is a statistically significant association between an increase in score and mortality as shown in Table 2. The risk of mortality increased with an increasing score, with the highest risk (OR=896) observed for score 4 as shown in Table 2.

Mortality is high in children with abnormal CFT (66.7%) compared to 2.2% in children with normal CFT. Abnormal capillary refill time is significantly associated with increased mortality (p<0.001) as shown in Table 3.

We observed a statistically significant association between the abnormal sensorium and the patient's clinical outcome (p<0.001) as shown in Table 3. Mortality was high among children with abnormal sensorium compared to those with normal sensorium (20.5% vs. 1.7% respectively). Abnormal systolic blood pressure has a very significant association with clinical outcome, with the majority of deaths observed (41.2%) presented with abnormal SBP as shown in Table 3. Abnormal pulse oximetry saturation is significantly associated with outcome (p<0.001) as shown in Table 3. 52.2% deaths were observed in patients with abnormal pulse oximetry saturation, while only 4.7% deaths occurred in children with normal $SPO_2$ levels.

**Table 3: Association of individual variable/vital with the mortality.**

| Variable | | Discharged (%) | Expired (%) | Chi square test | P value |
|---|---|---|---|---|---|
| **CFT** | Normal (316) | 309 (97.8) | 7 (2.2) | 158.196 | <0.001 |
| | Abnormal (30) | 10 (33.3) | 20 (66.7) | | |
| **Sensorium (AVPU)** | Normal (234) | 230 (98.2) | 4 (1.7) | 37.3152 | <0.001 |
| | Abnormal (112) | 89 (79.5) | 23 (20.5) | | |
| **Systolic BP** | Normal (312) | 299 (95.8) | 13 (4.2) | 58.3699 | <0.001 |
| | Abnormal (34) | 20 (58.8) | 14 (41.2) | | |
| **$SPO_2$ (pulse oximetry)** | Normal (323) | 308 (95.3) | 15 (4.7) | 67.4197 | <0.001 |
| | Abnormal (23) | 11 (47.8) | 12 (52.2) | | |

**Table 4: Predictive ability of total score and cut-off points all systems involved.**

| Cut off point (Total score) | Sensitivity (%) | Specificity (%) | Correctly classified (%) |
|---|---|---|---|
| **(≥0)** | 100 | 0 | 7.8 |
| **(>1)** | 96.3 | 70.2 | 72.3 |
| **(>2)** | 66.7 | 93.4 | 91.3 |
| **(>3)** | 51.9 | 98.4 | 94.8 |

(AUC= 0.913; p< 0.001; Highly significant)

A cut-off score of >1 has the highest sensitivity and specificity of 96.3% and 70.2% as shown in Table 4. AUC is 0.913, which implies that the total score has 90% predictive accuracy in relation to clinical outcome as in Figure 1.

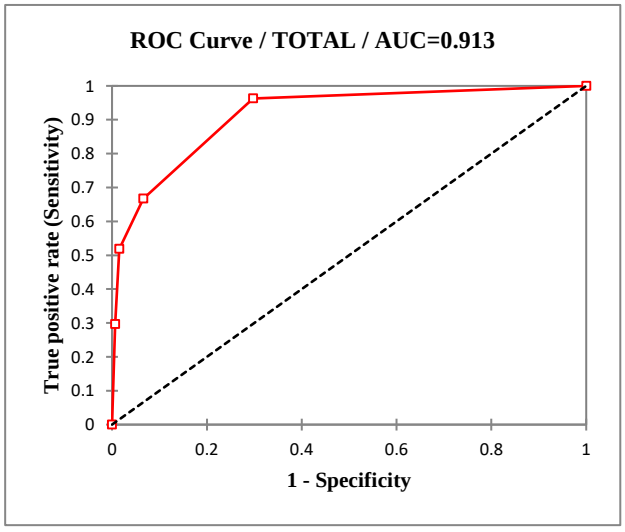


**Figure 1: Area under curve to assess the predictive ability of the score.**

## DISCUSSION

The study done by Thompson and colleagues has concluded that vital signs can identify sick children in paediatric emergency care with reasonable sensitivity compared to more complex triage systems.[13] Many of these existing scoring systems are developed for intensive care unit (ICU) patients and neonates and are not applied at admission; hence, these are not useful for initial triage.[16] Ideally, a triage system should be reliable and valid with a high rate of interobserver agreement, good correlation with resource use requirements, and clinical outcomes prediction.[17] The primary outcome was the death of any cause at 24 hours, based on the hypothesis that increasing under triage is associated with a higher 24-h mortality.[18] We set out to test a triage scoring system that utilizes only four vitals to predict the severity of illness and outcome. We felt that such a score based on vitals alone is proven to predict mortality and can probably be used in the emergency department (ED) as a method to triage in children so as to prioritize care and avoid harmful delays.

In our study, multisystem involvement caused the majority of the deaths, the probable explanation for which could be the onset of multi-organ dysfunction syndrome or MODS. CNS involvement can cause encephalitis, aspiration, increased intracranial pressure, which can lead to rapid progression and death. Among the children aged less than five years, the proportion of children who expired was high compared to children aged 5 to 12 years.

Mortality is high in children with abnormal CFT, sensorium, blood pressure, and oxygen saturation even as individual variables compared to children with normal values similar to studies done by Kumar et al and Pranam et al.[8,15] A cut-off score of >1 has the highest sensitivity and specificity of 96.3% and 70.2%. To conclude, a score of 2 has reasonable sensitivity and specificity to predict mortality in children, similar to a study done by Kumar et al.[15] An increase in score leads to a proportional increase in mortality.

One important limitation of our study is that the score was applied only to patients admitted to the hospital. There is the possibility of less sick-looking children may have been inappropriately sent home and might have expired without our awareness. If all children visiting the hospital-both in the OPD and the casualty were studied, the results could have been much more accurate.

This study is not a double-blinded study; hence there could be a possibility of bias. Another important source for bias is the recording of these clinical parameters by different paediatricians on duty. We did not look for interpersonal variability in recording vitals among the attending paediatricians, which might affect the results.

## CONCLUSION

Child with a score of 2 or more has a significant risk of higher mortality. A score of 2 or more suggests that the child requires admission to PICU and treatment. As no special training is needed for its implementation, we propose it as a triage tool in resource-poor settings. However, further studies are recommended to validate the score.

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