Original Article

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Physical and Non-invasive Variables of Emergency Triage in Relation to Outcome of Hospitalized Children

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Abstract

Introduction: Many deaths in under five children occurring in hospitals can be prevented if triage is followed, sick children identified, and treatment is started immediately.

Objective: To study the relationship of the physical and non-invasive variables of emergency triage and assess their predictive value for the severity and outcome of the illness.

Materials and Methods: This prospective study included all the patients between age 1 month and 5 years who were admitted on every 5th day consecutively over the duration of 1 year in a tertiary care hospital in Jammu. Seven physical and non-invasive variables: Heart rate, respiratory rate, systolic blood pressure (SBP), oxygen saturation (SPO2), capillary refill time (CRT), temperature (temp) and level of consciousness were recorded. Association of the variable with severity and mortality was assessed, and the significant variables were then subjected to stepwise multivariate logistic regression analysis.

Results: Of the 513 children studied, 85 (16.5%) died and out of these 57 (67.1%) exhibited all 7 variables in abnormal range and 28 (32.85%) deaths exhibited less than 7 abnormal variables. The probability of a fatal outcome in a child was as high as 95% in children with seven abnormal values. The probability of 19% with the presence of two abnormal variables. High sensitivity was observed throughout from 2 to 7 abnormal variables; however, specificity reduced drastically in <5 abnormal variables. The presence of any five abnormal variables, therefore, was considered to be the most appropriate cut-off between sensitivity and specificity in addition to yielding clinically useful predictive values. Subsequently, on multivariate analysis, altered SPO2, temperature, and SBP independently emerged as significant risk factors.

Conclusion: Any child with five or more of above-mentioned abnormal physical/non-invasive variables should be considered serious as he had a high probability of a fatal outcome.

Key words: Mortality, Pediatric emergency triage, Physical and non-invasive variables, Predictive value

INTRODUCTION

Morbidity and mortality in children particularly in the fewer than five age group is a prime concern of health care providers in developing countries. Deaths in hospitals occur most often within 24 h of admission. Many of these deaths can be prevented if any sick children are identified soon on their arrival and treatment is started immediately.[1] Many strategies have been identified to ensure the survival of such children in developing countries. In this respect "Triage" (derived from the "trier" meaning to pick, sort or choose) as a strategy has shown promising results in identifying and treating severely ill children.[2] Although protocols have been developed for primary and secondary triage, virtually none of these are evidence-based or have validated outcomes of their performance in real-time disasters.[3] Today triage is considered an essential component of every busy Emergency Department (ED),

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as an effort to provide efficient and prompt service in finite resources countries.[4] Triage should occur during the registration process but in majority of situations health care providers perform it after registration.[5] Guidelines for triage vary from center to center but the components of "Ideal" system reflect a delicate balance of prioritizing patients complaints based on brief selected information and findings.[6] Several pediatric prognostic scores are used for research purposes,[7] however, their performance characteristics limit their utility. As a basic requirement of any measurement tool, assessment of triage level should be similar among health professionals working in an ED as discrepancies in the triage level between nurses and physicians have been reported.[8-11] Reliability and accuracy of pediatric triage methods are limited as most previous researchers have studied a small number of participants included adult patients, or involved laboratory assistance, invasive variables.[9,11-13]

The present study was designed to evaluate the physical and non-invasive variables of emergency triage in relation to the outcome of hospitalized under five children of Jammu region (Table 1).

MATERIALS AND METHODS

A hospital based prospective study was undertaken in the department of Pediatrics S.M.G.S. Hospital, Government Medical College, Jammu which is a referral hospital not only for Jammu region but also for surrounding states. The study included all the patients between the age group of 1 month and 5 years who were admitted on every 5th day consecutively for a period of 24 h and over the duration of 1 year. Fifth day was chosen in an attempt to lessen inter-observer variation as the single observer was made responsible to record all the observations. After a detailed history, general physical and systemic examination, the seven physical and non-invasive variables viz. heart rate (HR), respiratory rate (RR), systolic blood pressure (SBP), oxygen saturation (SPO2), capillary refill Ttime (CRT), temperature (Temp.) and level of consciousness were recorded on a predesigned proforma. All the children were followed up till they were discharged. Patients who left against medical advice, absconded or transferred to the other hospitals were excluded from the study. The clinical variables were assessed by standardized methodology: BP – with sphygmomanometer with appropriate sized cuff measuring 1½", 2", 2½", 3". SPO2 was measured by pulse oximeter (Simed S-100, Bothal, W A98011). The oximeter probe was applied to the right thumb. Axillary temperature was measured by a mercury thermometer. Abnormal values for HR, RR, temperature and BP were taken according to standardized Systemic inflammatory response syndrome (SIRS) criteria.[14,15]

The Abnormal values for SPO2, CRT, and AVPU (alert, verbal, painful, unresponsiveness) were based on SIRS and Advanced Pediatric Life Support (APLS).[14,16]

Table 1: Cut-off values to classify physical and non-invasive variables as abnormal

Variable	Abnormal range
Temp	>38°C and <36°C
HR	2-12 months >160 per min 1-5 years >150 per min
RR	<2 months >60 breath/min 2-12 months >50 breath/min 1-5 years >40 breath/min
SBP	Infant <65 mmHg, Child <75 mmHg
SPO2	<90%
Consciousness (AVPU score)	A – Alert (normal) V – Responds to voice (abnormal) P – Respond to pain (abnormal) U – Unresponsive (abnormal)

HR: Heart rate, RR: Respiratory rate, SBP: Systolic blood pressure, SPO2: Oxygen saturation, Temp: Temperature

Statistical Analysis

The association of each of the variable with outcome was assessed using Chi-square. Odds ratio (OR) was calculated along with 95% confidence interval (CI) for each of the variables under study and their significance assessed. Adjusted values for the OR and 95% CI were determined by employing stepwise multivariate logistic analysis. All analysis were carried out using statistical software SPSS 12.0.1 for windows and EPI info version 6.0. The validity of each of the variables was calculated in terms of sensitivity, specificity, and predictive value vis-à-vis mortality.

RESULTS

A total of 513 children between 1 month and 5 years of age, admitted every 5th day over a period of 1 year were the subjects of the study.

The distribution of children with each clinical variable (normal/abnormal) along with outcome status shown in Table 2. Except for HR and RR all other variables were significantly associated with mortality.

- A total of 85 children died (16.5%) and out of these 57 (67.1%) exhibited all 7 variables in abnormal range whereas 28 (32.95%) deaths occurred among the children exhibiting less than 7 abnormal variables. In the group with 7 abnormal variables the sensitivity, specificity and positive predictive values (PPVs) were 67%, 99.3%, and 95% respectively. Subsequently the specificity and PPVs gradually decreased with

Table 2: Association of physical/non-invasive variables with the outcome

Variables	*N* (%)		OR (95% CI)	χ^2	*P* value
	Survived	Died			
HR	279 (93.6)	19 (6.4)	5.34 (2.99-9.62)	40.77	<0.001
	149 (69.3)	66 (30.7)			
RR	142 (34.1)	4 (2.73)	10.05 (3.66-38.44)	28.33	<0.001
	286 (77.9)	81 (22.0)			
SBP	318 (98.4)	5 (1.54)	46.25 (18.19-48.95)	142.35	<0.001
	110 (57.8)	80 (42.89)			
Temp	131 (94.2)	8 (5.7)	4.25 (1.97-10.46)	16.13	<0.001
	297 (79.4)	77 (20.5)			
SPO2	422 (97.3)	12 (12.7)	427.86 (143.13-66.49)	188.49	<0.001
	6 (7.6)	73 (7.6)			
CRT	419 (96.7)	14 (3.3)	236.10 (91.69-632.56)	157.22	<0.001
	9 (11.13)	71 (88.7)			
A (Alert)	353	Nil	1.0	N.A.	N.A.
V (responds to verbal command)	69 (86.3)	11 (13.7)	81.55 (23.14-333.52)	82.91	<0.001
P (responds to painful stimuli)	4 (07.2)	52 (92.8)	0.85 (0.12-7.25)	0.03	<0.001
U (Unconscious)	2 (08.3)	22 (9.17)	N.A.	N.A.	N.A.

HR: Heart rate, RR: Respiratory rate, SBP: Systolic blood pressure, SPO_2: Oxygen saturation, Temp: Temperature, CRT: Capillary refill time, OR: Odds ratio, CI: Confidence interval, N.A.: Not available

decreasing number of abnormal values from 91.4% to 16.4% and 69.4% to 19% respectively. The probability of a fatal outcome in a child which was as high as 95% in children with 7 abnormal variables fell to 19% in the presence of only 2 abnormal variables. The sensitivity was observed high throughout from 7 to 2 abnormal variable. However specificity sharply declined from 5 or less abnormal variables. This was observed as a significant cut-off point for predicting a high probability of fatal outcome (Table 3).

Multivariate analysis was also performed to assess the independent and coupled association of these variables with the risk for morality. It was observed that SPO2, temperature and SBP emerged as independent significant risk factors for the mortality (β coefficient Table 4).

Table 3: Number of abnormal variables and their predictive ability in relation to morality

No. of abnormal variables	Total no. of cases	Expired	Recovered	Predictive ability (%)	95% CI
7	60	57	34	Sens: 67.1	(55.9-76.7)
<7	453	28	425	Spec: 99.3	(97.8-99.8)
				PPV: 95	(85.2-98.7)
				NPV: 93.8	(91.1-95.8)
≥6	82	78	4	Sens: 91.8	(83.2-96.3)
<6	431	7	424	Spec: 97.2	(99.1-97.5)
				PPV: 95.1	(87.3-98.4)
				NPV: 98.4	(96.5-99.3)
≥5	121	84	37	Sens: 98.8	(92.7-99.9)
<5	392	1	391	Spec: 91.4	(88.2-93.8)
				PPV: 69.4	(60.3-77.3)
				NPV: 99.7	(98.4-100)
≥4	315	84	231	Sens: 98.8	(92.7-99.9)
<4	198	1	197	Spec: 46	(41.2-50.0)
				PPV: 26.7	(21.2-50.0)
				NPV: 99.5	(96.8-100)
≥3	392	84	309	Sens: 99.8	(92.7-99.9)
<3	120	1	119	Spec: 27.8	(23.7-32.4)
				PPV: 21.8	(17.5-25.8)
				NPV: 99.2	(94.8-100)
≥2	442	84	358	Sens: 98.8	(92.7-99.7)
<2	70	1	70	Spec: 16.4	(13.0-20.3)
				PPV: 19.0	(15.5-23.0)
				NPV: 98.6	(91.3-99.3)

Sens: Sensitivity, Spec: Specificity, PPV: Positive predictive value, NPV: Negative predictive value, CI: Confidence interval

DISCUSSION

The early identification of severe illness is extremely important for prioritizing treatment to reduce childhood mortality and allow proper utilization of limited resources in the developing world.[14] Emergency triage is the sorting or prioritizing of patients who requires prompt medicare. Various scoring systems - Prism Score and Triage score have been proposed to assist in assessing the severity of illness at the time of presentation to the heath care center. These scoring systems predict the risk of mortality in a given patient.[13,17] However, most of the scoring systems are devised for the ICU patients and they rely not only physical but also laboratory variables many of which are not available in most of the health centers in our country. This makes them unsuitable for practice in developing countries, especially in the ever busy pediatrics EDs. W.H.O. developed guidelines for emergency triage assessment and treatment of sick children suffering from serious infections or severe malnutrition presenting to hospitals in the developing countries. It prioritizes treatment of sick children depending upon the emergency signs (related to airways, breathing, circulation, coma, convulsion, confusion and dehydration) to decrease mortality.[15] Recently in an

Table 4: Standardized regression co-efficient for variables under study

Variables	"β" - coefficient
SPO2	0.727
Temp	0.29
SBP	0.021
HR	0.015
RR	0.004

HR: Heart rate, RR: Respiratory rate, SBP: Systolic blood pressure, SPO_2: Oxygen saturation, Temp: Temperature

attempt to improve the Manchester Triage System by adding vitals to the triage scale it was seen that the outcome predictability remained same.[18] The major limitations of emergency triage application are a requirement of reorganization of the existing health care system and special training of both medical and paramedical staff.[13] Various studies conducted for triage lack uniformity regarding the basic methodology. The heterogeneity in age groups, selection of subjects, or parameters and application of the scoring system by different classes of health workers make the issue further more complex. The fact that poorly equipped healthcare facilities of developing countries may not have the required laboratory assistance for invasive variables or if available they would be time consuming, the physical and non-invasive variables which would be practically feasible to apply were carefully selected for the study and analyzed for the outcome of illness.

Heart Rate

W.H.O. guidelines include Tachycardia, as an important sign for assessing most of the febrile illnesses and cardiac diseases with failure.[15] It was observed that tachycardia had a significant association with the mortality pattern (OR: 5.34; 95% CI: 2.99-9.62). Its significance in relation to mortality was also studied in different age groups of the children i.e. >1-12 months and 1-5 years (OR: 4.80; 95% CI: 3.08-12.92) respectively. These observations differ from the observation of Kumar *et al.*,[13] who did not observe it to be a significant independent risk factor for mortality.

Respiratory Rate

Tachypnea was observed to have a significant association with the mortality pattern (OR: 10.05; 95% CI: 3.66-37.44). Its significance with the risk of mortality was also evaluated with regard to different age groups of the children i.e., 2-12 months and 1-5 years (OR: 3.60; 95% CI: 0.43-79.07) and (OR: 9.26; 95% CI: 2.88-47.15) respectively, which was observed to be maximum in 1-2 months age (93.7%), followed by 2-12 months (33%) and 17.5% in 1-5 years age group. These results differ from the reports available in the literature, Kumar *et al.*[13] did not observe it to be significant independent risk factor for mortality. Further Hooker *et al.* observed that the wide range of 'normal' pediatric RRs makes identification of "abnormal" more difficult.

Systolic Blood Pressure

It was observed that hypotension had a highly significant relation with the mortality pattern (OR: 46.25; 95% CI: 18.19-148.95) which was maximum in the age group of 1-12 months as compared to 1-5 years age (OR: 59.65; 95% CI: 8.64-247.59) and (OR: 37.91; 95% CI: 13.16-147.61) respectively. These results are comparable with observations of Kumar *et al.* (OR: 16.5; 95% CI: 5.7-47.8).[13]

Temperature

Temperature forms an important sign in the pediatric age group for evaluation of severity, diagnosis and management of childhood illness. It was observed that the temperature in the abnormal limits i.e., hypothermia or fever (<36°C/>38°C) had a significant association with the fatal outcome (OR: 4.25; 95% CI: 1.97-10.46).

Oxygen Saturation

<90% was observed to be a highly significant risk factor for mortality (OR: 427.86; 95% CI: 143-1366.49). These results are similar to the observations of Kumar *et al.*[13] (<90%) (OR: 9.3; 95% CI: 15-17.4).

Capillary Refill Time

CRT is an important simple clinical besides indicator for assessment of circulatory status. If prolonged (>3 s) it is considered abnormal. We observed it to be a highly significant risk factor associated mortality (OR: 236.10; 95% CI: 91.69-632.56). The results are comparable to the observations of Kumar *et al.* (OR: 7.8; 95% CI: 4.0-15.2), and Leonard and Beattie.[13,19]

AVPU Scale

AVPU scale helps in easy and quick assessment of coma.[15] AVPU – The acronym; A = the child is alert and awake, V = responds to verbal command, P = responds to painful stimuli (e.g. pinching or pulling frontal hair), U = Unconscious. Maximum mortality was observed in (92.85%) in 'P'–score patients followed by 'U' (91.7%) and subsequently 'V' (13.7%) scores respectively. No death occurred among alert children category A. However, 'V' and 'P' categories had a highly significant association with the fatal outcome of children OR: 81.55; 95% CI: 22.14-333.52 and OR: 85; 95% CI: 0.12-7.25 respectively. These results are comparable with the observation of Kumar *et al.*[13] (OR: 11.0; 95% CI: 5.9-20.6).

CONCLUSION

Triage is a vital and indispensable part of healthcare delivery system which can prevent mortality by quicker

identification of severe childhood illnesses which facilities prompt management as soon as they arrive at the health care center.

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