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Comparison between Pediatric-Canadian Triage and Acuity Scale and South African Triage Scale Regarding Applicability and Outcome in the Pediatric Emergency Department, Suez Canal University Hospital

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Abstract

Background

The triage system is a systematic approach to organize priority of treatment amongst patients attending emergency departments (EDs). A variety of triage systems are implemented in different hospitals with consideration of local settings such as available resources, patient capacity of each ED. The more popular triage systems with high reported validity and reliability rates in children include the

Pediatric Canadian Triage and Acuity Scale (PaedCTAS) and the Pediatric South African Triage Scale (P-SATS).

Aim

Improve the management in the Pediatric Emergency Department (PED), Suez Canal University Hospital by applying a valid and reliable triage system.

Patients and Methods

This study was performed as a single-center study to determine the validity of PaedCTAS and P-SATS. The researcher performed two triage systems through a data collection sheet. The primary outcome of the analysis was the proportion of hospital admissions. Secondary outcomes analyzed were the percentage of patients enrolled in the Pediatric Intensive Care Unit (PICU), the duration of stay (LOS) (<2 hours and >2 hours), and mortality in the PED. The validity of the two triage systems was analyzed using the area under the ROC curves which are the receiver operating characteristics.

Results

PaedCTAS was slightly more accurate than P-SATS for triaging the patients attending the Pediatric Emergency Department, Suez Canal University Hospital as PaedCTAS performed better than P-SATS in prediction of PICU admission, LOS and mortality. However, regarding the prediction of admission P-SATS performed better.

Conclusion

Both paedCTAS and P-SATS are valid triage tools for patients attending the Pediatric Emergency Department, Suez Canal University Hospital with paedCTAS being slightly more accurate than P-SATS.

Keywords: PaedCTAS, P-SATS, admission, mortality.

List of Abbreviations

ATS Australasian Triage Scale

CTG The Cape Triage Group

ED Emergency Department

LOS Length of stay

ESI Emergency Severity Index

P-SATS Pediatric South African Triage Scale

PaedCTAS Pediatric Canadian Triage and Acuity Scale

PICU Pediatric intensive care unit

TEWS Triage Early Warning Score

Introduction

The utilization of triage frameworks looks to help tolerant association to guarantee smooth patient stream. In the crisis division "triage" focuses to the capacity to evaluate patients' seriousness of injury or sickness inside a brief timeframe after appearance to the Pediatric Emergency Department, dole out their needs, and move every patient to the fitting spot for treatment (Grossmann et al., 2018). In a situation involving limitations and other exceptional variables, treatment options can be made with time constraints, using limited data (Stone et al., 2019). Triage is gotten from "trier" in French, which means isolating, sorting or characterizing, and alludes to the characterization, classification, and prioritization of patients and harmed individuals, in light of their pressing requirement for treatment (Twomey et al., 2013).

The more famous triage frameworks with high announced legitimacy and dependability rates incorporate the Manchester Triage Scale (MTS), the Pediatric Canadian Triage and Acuity Scale (PaedCTAS), Emergency Severity Index (ESI), South African Triage Scale (P-SATS) and the Australasian Triage Scale (ATS) (Grossmann et al., 2018). While these frameworks show contrasts in certain subtleties, for example, the rules of characterization of every framework and its rules, all frameworks order patients for the most part as far as criticalness which is the primary objective from usage of the triage framework.

In this examination, we will evaluate the appropriateness and result of the Pediatric Canadian Triage and Acuity Scale (PaedCTAS), and the South African Triage Scale (P-SATS). Our defense for that will be that the PaedCTAS is one of the most well-known, substantial, and relevant triage system in the world while the P-SATS is used and has been assessed in numerous asset poor settings, for example, low-and center salary nations (Ebrahimi et al., 2015).

CTAS primarily relies on a group of patients who provide protest modifiers (first and second request) for obvious conditions (Gravel, J. et al., 2012). In 2001, a pediatric adaptation of CTAS was created (Paid CTAS). Its operational benefit is mainly determined by the possibility of adapting it to patient-based assessment (Fernández et al., 2017). Clinical evaluation should be given within 15 minutes for Level 1 and Clinical Level 2, 30 minutes for Level 3, one hour for Level 4, and 120 minutes for Level 5 (Westwood et al., 2013).

The Pediatric South African Triage Scale (P-SATS), also known as the Cape Triage score, was discharged in 2004 and revived in 2009 by the South African Triage Group (Pearson et al., 2011). P-SATS are made from four shading coded classes: Crisis (Red), Fear (Orange), Press (Yellow) and Non-Dear (Green). Triage in the P-SATS Framework relies heavily on rapid assessment of clinical information, combined with an age-related composite physiological score, known as the Triage Early Warning Score (TEWS). Points are given for normal versus abnormal mobility, heart rate, respiratory rate, temperature and the presence or absence of trauma. There are two pediatric versions of the TEWS, one for the younger child (less than 3 years) and one for the older child (older than 3 years). If any emergency clinical signs are found at triage, no TEWS calculation is done (Gottschalk et al., 2006).

In excess of 300 patients for each day visit the pediatric crisis office, Suez Canal University Hospital and this number is expanding. It is accordingly fundamental that we use a precise way to deal with organizing the consideration of patient dependent on the clinical criticalness. Considering stuffed and understaffed conditions in the ED, fast and precise triaging will help sort out the progression of patients and organize basic patients for being seen by the pediatric crisis group. Also, association of work in ED assists with upgrading usage of doctors' time and diminishing death rates by early discovery of patients with conditions requiring time-touchy treatment during the 'golden hour'.

Objective

To assess if the two international triaging systems (PaedCTAS and P-SATS) can predict admission and mortality in the Pediatric Emergency Department, Suez Canal University Hospital as a criterion of assessment of their validity.

Patients and Methods

This study was conducted as a prospective cohort, single-center study to determine the validity of PaedCTAS and P-SATS.

The study population was patients presenting to the Pediatric Emergency Department, Suez Canal University Hospital. Any patient ranging in age from birth to 12 years attending the Pediatric ED during the period of data collection whose parents agreed to participate by written consent was included in the study.

Patients who presented with trauma, psychiatric, dental and surgical concerns were excluded.

Consecutive sampling was used. Any patient eligible for the investigation's models and going to the Pediatric ED during the time of information assortment when the specialist was not on the job was picked.

The two triage systems were led by the researcher when not working. An information assortment sheet was structured and the triage level was dictated by the pediatric resident. The sheet included social and demographic information, clinical information (chief complaint, level of consciousness, vital signs, previous admissions to the hospital and chronic illnesses) and triage information (classification doled out by pediatric resident, complete length of stay in the ED, further medical clinic affirmation, further PICU admission and mortality). To dissect legitimacy of every triage system, patients were separated into high acuity (triage level 1, 2) and low acuity (triage level 3, 4, 5). Accordingly, the degrees of acuity were contrasted and the result measures. Validity was measured using area under the receiver operating characteristics ROC curves. The five levels of the Canadian Triage and Acuity Scale are:

Level I – Resuscitation: “conditions that are threats to life or limb (or imminent risk of deterioration) requiring aggressive interventions” (to be seen immediately).
Level II – Emergent: “conditions that are a potential threat to life, limb or function, requiring rapid medical intervention” (to be seen <15 min).
Level III – Urgent: “conditions that could potentially progress to a serious problem requiring emergency intervention. May be associated with significant discomfort or affect ability to function at work or in activities of daily living” (to be seen <30 min).
Level IV – Less Urgent: “conditions that relate to patient age, distress, or potential

for deterioration that would benefit from intervention or reassurance within one or two hours” (to be seen <60 min).

Level V – Non-Urgent: “conditions that may be acute but non-urgent as well as conditions which may be part of a chronic problem with or without evidence of deterioration. The investigation or interventions for some of these illnesses or injuries could be delayed or even referred to other areas of the hospital or health care system” (to be seen <120 min) **(Arafat et al., 2016)**.

The triage categories of the P-SATS are:

- **Red** - resuscitation/physiologically unstable patients
- **Orange** - serious cases with potentially unstable physiology or potentially life/limb threatening pathology
- **Yellow** - ‘physiologically stable’ cases with reasonably serious medical or trauma problems
- **Green** - minor injuries/illness

The essential result measure dissected was the extent of hospitalization. We characterized hospitalization as patient admission to the emergency clinic ward.

Optional results examined were the level of patients admitted to the pediatric emergency unit, the length of stay (LOS) in the PED (<2 hours and ≥2 hours) and mortality. Different factors recorded during the triage, explicitly age, sexual orientation and clinical information were investigated as markers of seriousness.

Each triage system utilized the main complaint and some physiological parameters such as respiratory rate, oxygen saturation, body temperature, heart rate, blood pressure, respiratory distress, and capillary refill time to detect patients’ level of acuity. Every triage system had levels of severity. Level1 triage was the most emergent treatment, while level5 triage was the least rising treatment.

Statistical Analysis

Data were cataloged and analyzed using the IBM SPSS software package version 20.0. (Armonk, NY: IBM Corporation) Qualitative data are interpreted by number and percentage.

Statistics used

1 - Chi-square test

For categorical variables, compare different groups

2 - Monte Carlo correction

Correction for Chi-Square if the number in the 20% cells is less than 5

3 - Receiver Operating Characteristic Curve (ROC)

This was created by plotting the sensitivity (TP) on the Y axis and 1-specificity (FP) on the X axis with different cut-off values. The area under the ROC curve represents the diagnostic performance of the test. More than 50% of the area provides acceptable performance, and 100% of the area is excellent for testing. The ROC curve also allows you to compare performance between two tests.

4 - Sensitivity

The ability to correctly classify people with triage levels related to a particular condition in a population (TRUE POSITIVES). It is usually used to compare the gold standard. There was no Trez Systems gold standard in our research, so we used the surrogate gold standard, which was the actual admission rate, PICU admission, stay period, and mortality. Increased sensitivity, number of patients being tested

5 - Specialization

The ability to correctly classify individuals with triage levels unrelated to a particular condition in a population (TRUE NEGATIVES). More specifically, the number of over-screened patients is “false-positive”

6 - Positive Prediction Value (PPV)

Specific condition risk in people with adjuvant therapeutic status

7 - Negative Prediction Value (NPV)

Risk of non-specific status in those not associated with triage levels

Ethical Considerations

The researcher guaranteed that the exploration didn't defer or interfere with work execution or patients' administration. Member's families were educated with the point of the examination and its advantage to their kid and the network. Composed educated assent was acquired from the guardians. Classification of information gathered was guaranteed, and that no information will be utilized outside this investigation without assent. The family reserved the option to pull back from the exploration whenever or even decline to take an interest from the earliest starting point with no impact on the choices made for the arrangement of the administration.

Results

The two triage systems were conducted by the researcher through a data collection sheet that included demographic data, medical data and triage data (category, LOS, further hospitalization, PICU admission and mortality). Patients were divided into high acuity (triage level 1, 2) and low acuity (triage level 3, 4, 5). Subsequently, the levels of acuity were compared with the outcome measures. Then the validity of the two triage systems was assessed utilizing area under the receiver operating characteristics ROC curves. The outcome measures were hospitalization, LOS, PICU admission and mortality.

Table (1): Distribution of the studied cases according to demographic data (n=310)

	No.	%
Sex		
Male	139	44.8
Female	171	55.2
Age		
0 – 6 months	83	26.8
6 months – 3years	97	31.3
3years – 12years	130	41.9

During the study period, a total of 310 patients met the selection criteria of which, 139 were male (44.8%) and 171 were female (55.2%). As regards age, the largest group seen was those between 3yrs – 12yrs (41.9%). (Table 1)

Table (2): Distribution of the studied cases according to CTAS (n=310)

CTAS	No.	%
I	14	4.5
II	27	8.7
III	145	46.8
IV	112	36.1
V	12	3.9

PaedCTAS triage levels I, II, III, IV and V are represented by 14, 27, 145, 112 and 12 patients, respectively. (Table 2)

Table (3): **Distribution of the studied cases according to P-SATS (n=310)**

SATS	No.	%
Red	22	7.1
Orange	65	21.0
Yellow	99	31.9
Green	124	40.0

P-SATS triage levels Red, Orange, Yellow, and Green are represented by 22, 65, 99 and 124 patients, respectively. (Table 3)

Table (4): **Relation between paedCTAS triage category and length of stay (LOS) (n=310)**

Length of stay (LOS)	PaedCTAS triage category										χ^2	^{MC}p
	I (n=14)		II (n=27)		III (n=145)		IV (n=112)		V (n=12)			
	No.	%	No.	%	No.	%	No.	%	No.	%		
Less than 1 hour	6	42.9	8	29.6	0	0.0	48	42.9	11	91.7	187.566*	<0.001*
1:2 hours	5	35.7	18	66.7	78	53.8	64	57.1	1	8.3		
2:3 hours	0	0.0	0	0.0	1	0.7	0	0.0	0	0.0		
More than 3 hours	3	21.4	1	3.7	66	45.5	0	0.0	0	0.0		

\χ^2: **Chi square test** MC: **Monte Carlo**
p: p value for comparing between **the different categories**
*: Statistically significant at $p \leq 0.05$

The relation between PaedCTAS triage category and length of stay (LOS) was statistically significant ($p \leq 0.05$). As the LOS of the patients with triage category I showed that 42.9% stayed less than 1 hour due to rapid transfer to the PICU, while this percentage decreased with triage category II and III. However, this percentage increased again with triage category IV, V due to direct discharge after examination (Table 4).

Table (5): Relation between paedCTAS triage category and discharge, hospitalization and PICU admission (n=310)

	CTAS triage category										χ^2	^{MC}p
	I (n=14)		II (n=27)		III (n=145)		IV (n=112)		V (n=12)			
	No.	%	No.	%	No.	%	No.	%	No.	%		
Discharge	3	21.4	9	33.3	97	66.9	110	98.2	11	91.7	139.159*	<0.001*
Hospitalization	3	21.4	6	22.2	48	33.1	2	1.8	1	8.3		
PICU admission	8	57.1	12	44.4	0	0.0	0	0.0	0	0.0		

χ^2: **Chi square test** MC: **Monte Carlo**
p: p value for comparing between **the different categories**
*: Statistically significant at $p \le 0.05$

The proportion of the patients admitted to our hospital was strongly associated with the PaedCTAS level ($p \le 0.05$). PICU admission according to PaedCTAS levels were 57.1, 44.4, 0, 0 and 0% for PaedCTAS levels I, II, III, IV and V, respectively. A strong association was found between the proportion of PICU admissions and PaedCTAS level ($p \le 0.05$). (Table 5)

Table (6): Relation between paedCTAS triage category and mortality (n=310)

Mortality	CTAS triage category										χ^2	^{MC}p
	I (n=14)		II (n=27)		III (n=145)		IV (n=112)		V (n=12)			
	No.	%	No.	%	No.	%	No.	%	No.	%		
No	9	64.3	26	96.3	145	100.0	112	100.0	12	100.0	29.915*	<0.001*
Yes	5	35.7	1	3.7	0	0.0	0	0.0	0	0.0		

χ^2: **Chi square test** MC: **Monte Carlo**
p: p value for comparing between **the different categories**
*: Statistically significant at $p \le 0.05$

The relation between paedCTAS triage category and mortality was statistically significant ($p \le 0.05$). As mortality rates according to PaedCTAS levels were 35.7, 3.7, 0, 0 and 0% for PaedCTAS levels I, II, III, IV and V, respectively. (Table 6)

Table (7): Relation between P-SATS triage category and length of stay (LOS)

Length of stay (LOS)	SATS triage category								χ^2	^{MC}p
	Red (n=22)		Orange (n=65)		Yellow (n=99)		Green (n=124)			
	No.	%	No.	%	No.	%	No.	%		
Less than 1 hour	6	27.3	8	12.3	0	0.0	59	47.6	220.662*	<0.001*
1:2 hours	13	59.1	57	87.7	32	32.3	64	51.6		
2:3 hours	0	0.0	0	0.0	1	1.0	0	0.0		
More than 3 hours	3	13.6	0	0.0	66	66.7	1	0.8		

χ^2: **Chi square test** MC: **Monte Carlo**
p: p value for comparing between **the different categories**
*: Statistically significant at $p \leq 0.05$

The relation between P-STAS triage category and length of stay (LOS) was statistically significant ($p \leq 0.05$). As the LOS of the patients with the red triage category showed that 27.3% stayed less than 1 hour due to rapid transfer to the PICU, while this percentage decreased with the orange and yellow triage category. However, this percentage increased again with the green triage category due to direct discharge after examination (Table 7)

Table (8): Relation between P-SATS triage category and discharge, hospitalization and PICU admission (n=310)

	SATS triage category								χ^2	^{MC}p
	Red (n=22)		Orange (n=65)		Yellow (n=99)		Green (n=124)			
	No.	%	No.	%	No.	%	No.	%		
Discharge	3	13.6	31	47.7	74	74.7	122	98.4	127.121*	<0.001*
Hospitalization	13	59.1	20	30.8	25	25.3	2	1.6		
PICU admission	6	27.3	14	21.5	0	0.0	0	0.0		

χ^2: **Chi square test** MC: **Monte Carlo**
p: p value for comparing between **the different categories**
*: Statistically significant at $p \leq 0.05$

The proportion of the patients admitted to our hospital was strongly associated with the P-SATS level ($p \leq 0.05$). PICU admission according to P-SATS levels were 27.3, 21.5, 0 and 0% for P-SATS levels Red, Orange, Yellow and Green, respectively. A strong association was found between the proportion of PICU admissions and P-SATS level ($p \leq 0.05$). (Table 8)

Table (9): Relation between P-SATS triage category and mortality (n=310)

Mortality	SATS triage category								χ^2	^{MC}p
	Red (n=22)		Orange (n=65)		Yellow (n=99)		Green (n=124)			
	No.	%	No.	%	No.	%	No.	%		
No	20	90.9	61	93.8	99	100.0	124	100.0	13.282*	0.001*
Yes	2	9.1	4	6.2	0	0.0	0	0.0		

χ^2: **Chi square test** MC: **Monte Carlo**
p: p value for comparing between **the different categories**
*: Statistically significant at $p \leq 0.05$

The relation between P-SATS triage category and mortality was statistically significant ($p \leq 0.05$). As mortality rates according to PaedCTAS levels were 9.1%, 6.2, 0 and 0% for P-SATS levels Red, Orange, Yellow and Green, respectively. (Table 9)

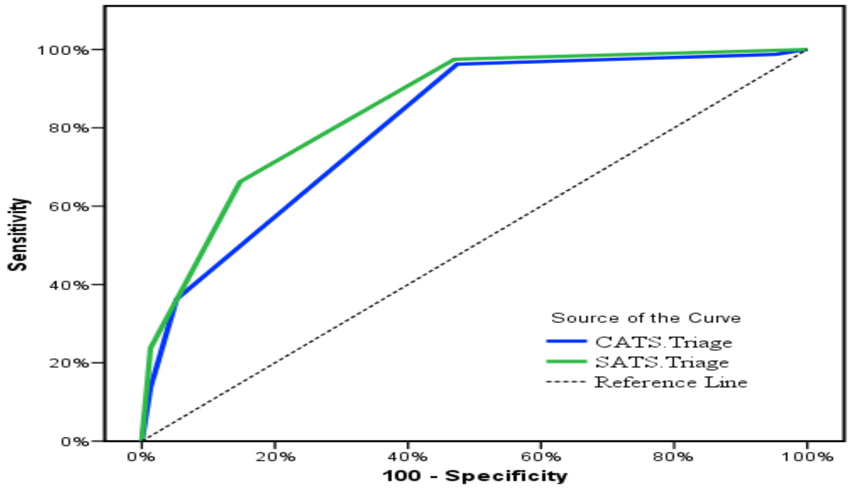

Figure (1): ROC curve for different parameters to predict admission

Table (10): Agreement (sensitivity, specificity) different parameters to predict admission

	AUC	p-value	95% C.I	Cut off	Sensitivity	Specificity	PPV	NPV
CTAS triage	0.804	<0.001*	0.752 – 0.856	**≤3**	96.25	52.61	41.4	97.6
SATS triage	0.849	<0.001*	0.804 – 0.895	**≤2**	66.25	85.22	60.9	87.9

AUC: Area Under a Curve
p value: Probability value
CI: Confidence Intervals
NPV: Negative predictive value
PPV: Positive predictive value
*: Statistically significant at $p \leq 0.05$

When hospitalization was used, CTAS sensitivity was 96.25, specificity was 52.61, PPV was 41.4, NPV was 97.6 and AUC was 0.804, while STAS sensitivity was 66.25, specificity was 85.22, PPV was 60.9, NPV was 87.9 and AUC was 0.849 (Table 10). Figure 1 shows ROC curve for both CTAS and SATS to predict admission.

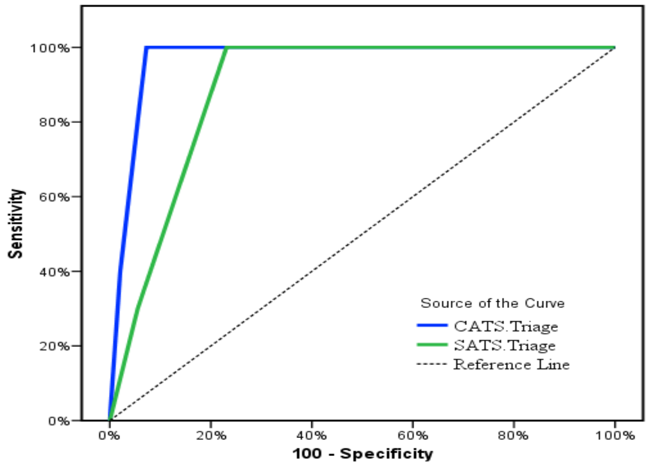

Figure (2): ROC curve for different parameters to predict PICU admission

Table (11): Agreement (sensitivity, specificity) different parameters to predict PICU admission

	AUC	p-value	95% C.I	Cut off	Sensitivity	Specificity	PPV	NPV
CTAS triage	0.968	<0.001*	0.949 – 0.986	**≤2**	100.0	92.76	48.0	100.0
SATS triage	0.892	<0.001*	0.851 – 0.933	**≤2**	100.0	76.90	23.0	100.0

AUC: Area Under a Curve
p value: Probability value
CI: Confidence Intervals
NPV: Negative predictive value
PPV: Positive predictive value
*: Statistically significant at $p \leq 0.05$

When PICU admission was used, CTAS sensitivity was 100.0, specificity was 92.76, PPV was 48.0, NPV was 100.0 and AUC was 0.968, while STAS sensitivity was 100.0, specificity was 76.90, PPV was 23.0, NPV was 100.0 and AUC was 0.892 (Table 11). Figure 2 shows ROC curve for both CTAS and SATS to predict PICU admission.

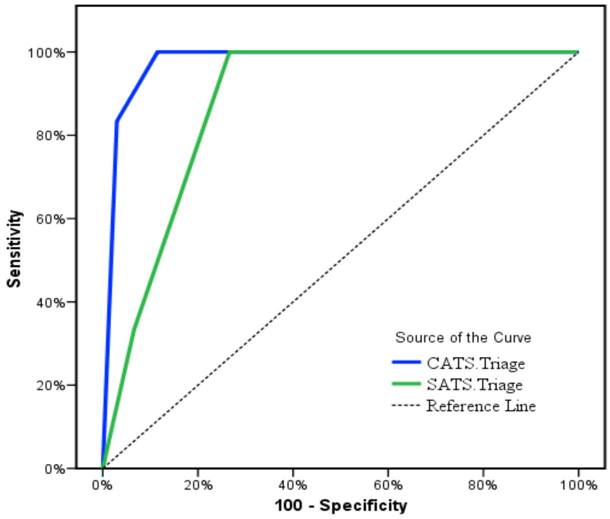

Figure (3): ROC curve for different parameters to predict mortality

Table (12): Agreement (sensitivity, specificity) different parameters to predict mortality

	AUC	p-value	95% C.I	Cut off	Sensitivity	Specificity	PPV	NPV
CTAS triage	0.976	<0.001*	0.952 – 1.0	**≤2**	100.0	88.49	14.6	100.0
SATS triage	0.878	0.002*	0.808 – 0.947	**≤2**	100.0	73.36	6.9	100.0

AUC: Area Under a Curve
p value: Probability value
CI: Confidence Intervals
NPV: Negative predictive value
PPV: Positive predictive value
*: Statistically significant at $p \leq 0.05$

When mortality was used, CTAS sensitivity was 100.0, specificity was 88.49, PPV was 14.6, NPV was 100.0 and AUC was 0.976, while STAS sensitivity was 100.0, specificity was 73.36, PPV was 6.9, NPV was 100.0 and AUC was 0.878 (Table 12). Figure 3 shows ROC curve for both CTAS and SATS to predict mortality.

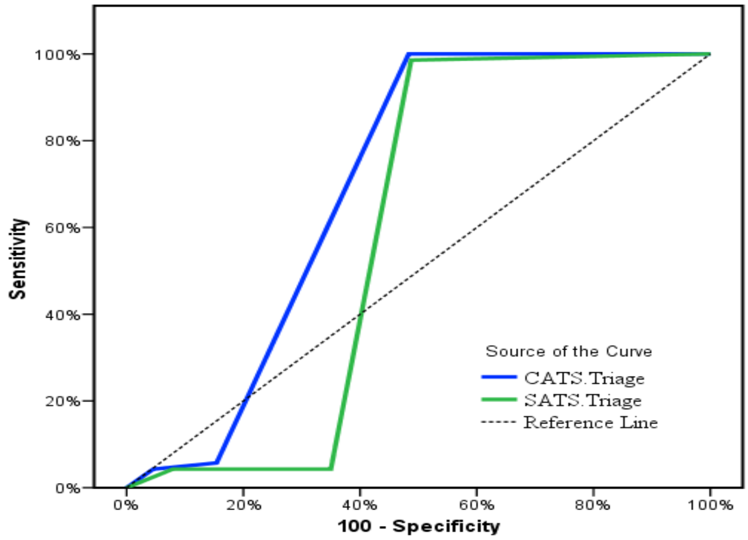

Figure (4): **ROC curve for different parameters to predict length of stay (>2 hours)**

Table (13): **Agreement (sensitivity, specificity) different parameters to predict length of stay (>2 hours)**

	AUC	p-value	95% C.I	Cut off	Sensitivity	Specificity	PPV	NPV
CTAS triage	0.697	<0.001*	0.642 – 0.752	**≤3**	100.0	51.67	37.6	100.0
SATS triage	0.593	0.018*	0.532 – 0.654	**≤2**	98.57	51.25	37.1	99.2

AUC: Area Under a Curve
p value: Probability value
CI: Confidence Intervals
NPV: Negative predictive value
PPV: Positive predictive value
*: Statistically significant at $p \leq 0.05$

When LOS was used, CTAS sensitivity was 100.0, specificity was 51.67, PPV was 37.6, NPV was 100.0 and AUC was 0.697, while STAS sensitivity was 98.57, specificity was 51.25, PPV was 37.1, NPV was 99.2 and AUC was 0.593 (Table 13). Figure 4 shows ROC curve for both CTAS and SATS to predict LOS.

Discussion

Within a short period of time in the Emergency Department, it is important to assess the severity of the disease, determine priorities and move each patient to the appropriate location for treatment. It is important to identify the most urgent cases to ensure that they receive priority treatment, and then there are fewer emergency cases on a first-serve basis.

Therefore, this study was set with the aim of assessing the validity of PaedCTAS and P-SATS as triage systems for patients presenting to the pediatric emergency department, Suez Canal University Hospital. In this single-center study, we included 310 pediatric patients who were triaged according to both PaedCTAS and P-SATS upon presentation to the emergency department of which, 139 were male (44.8%) and 171 were female (55.2%). As regards age, the largest group seen was those between 3yrs – 12yrs (41.9%). Among the patients, there were 33 patients (10.6%) with previous history of hospital admission and 27 patients (8.7%) with chronic illness.

In the current study, because there was no gold standard for the study, each triage system used alternative markers to determine the validity of the system. To do so, the expected primary outcome was hospital admission defined by all patients that were admitted by the treating physician. Secondary outcomes were different signs of severity, such as LOS of the ED and admission into the PICU after seeing a physician.

The proportion of the patients admitted to our hospital was strongly associated with the PaedCTAS level ($p \leq 0.05$). PICU admission according to PaedCTAS levels were 57.1, 44.4, 0, 0 and 0% for PaedCTAS levels I, II, III, IV and V, respectively. A strong association was found between the proportion of PICU admissions and PaedCTAS level ($p \leq 0.05$). These findings suggest the validity of the PaedCTAS to predict the urgency and the severity of each presentation.

Our findings further support the results of previous studies. Yates and colleagues assessed the efficacy of PaedCTAS as a measure of injury severity and reported that the child admission ratio was high when PaedCTAS scores decreased. Of all PaedCTAS I admissions, only 1.6% of PaedCTAS IV children were enrolled ($p = 0.000$). According to the logistic regression, children rated as PaedCTAS II were more likely to be hospitalized compared to children with PaedCTAS III (Yates et al., 2016). Gravel and colleagues conducted a multicenter study, including 1,464 patients, which showed that triage level was strongly associated with hospital admission because children with higher therapeutic levels (less severe) were less likely to be hospitalized. Furthermore, by uniform logistic regression, they demonstrated a strong association between treatment level and hospitalization (Gravel et al., 2012). Another large multicenter retrospective cohort study retrieved data from ED computerized databases, including a total of 550,940 children, assigned triage levels to a paid CTAS and surrogate markers of validity for real-life children tested in multiple emergency departments (Dallaire et al., 2010). In addition, 79% of patients admitted to the ICU were tested at Level 1 or 2. However, 31 children in the fourth level and 3 children in the 5th level were enrolled in the ICU (Gravel et al., 2012). Furthermore, in their retrospective study, Grewal et al. The proportion of hospital admissions was shown to be robust to triage status. Among patients tested for the fifth level, it ranged from 0.7% to 6 level 1 ($P < 0.001$). Admission into the PICU was strongly associated with the Triage level, demonstrating that 90% of patients enrolled in the PICU were initially screened at the level of 1 or 2 ($p < 0.001$) (Gravel et al., 2012).

The proportion of patients admitted to our hospital was strongly correlated with the P-SATS level ($P < 0.05$). In terms of P-SATS levels, PICU admission was 27.3, 21.5, 0 and 0% for P and SATS levels, respectively, for red, orange, yellow, and green. A strong correlation was found between the PICU threshold ratio and the P-SATS level ($p \leq 0.05$).

Our findings are consistent with those of Engen and colleagues who reported that hospital admission rates in green, yellow, orange, and red were 30%, 44%, 57%, and 81%, respectively. This improvement in hospital admission was statistically significant ($p < 0.001$) for the immediately developing triage Priority. In addition, the odds ratio (OR) for hospital admission was 3.2 (95% confidence interval (CI) 1.5– 6.4), 5.3 (95% CI 2.8–10.2), and 9.9 (95% CI 5.2) –19.1). For orange and red, respectively (Engan et al., 2018). Similar results were demonstrated in the assessment of the use of the South African Triage Scale at the Urban District Hospital in Durban, South Africa (Soogun et al., 2017). If you are a red code patient, the chance of admission is 17.9 ($p = 0.01$), 1.7 ($p = 0.3$) if you are coded in orange, 1.4 ($p = 0.7$) if you are coded in yellow, and 0.5 ($p = 0.02$) if you are coded as green. Only patients coded as red codes were hospitalized, and green coded patients differed significantly from those without admission (Fernández et al., 2017). Twomey and colleagues in 2012 conducted a multicenter study, including a 2014 study, which showed that treatment level was strongly associated with hospital admission, as children with therapeutic acuity were less likely to be hospitalized. Furthermore, by logistic regression, they demonstrated a strong correlation between treatment level and the risk of hospitalization. The percentage of hospital admissions increased from 5% in emergency to 73% in emergency patients (Pearson et al., 2011).

LOS in the ED after being seen by a physician might be an indicator of the acuity of the patient's condition. We found that the relation between paedCTAS triage category and the LOS was statistically significant ($p \leq 0.05$). Similar observations were found by the P-SATS triage ($p \leq 0.05$). As a longer length of stay in the ED was noted for patients with more accurate triage levels of both the paedCTAS and P-SATS. However, 42.9% of patients with paedCTAS triage category I and

27.3%of patients with Red P-SATS triage category stayed less than one hour. That could be explained by the rapid admission into the PICU for these patients.

In line with these findings, Yates et al. reported that the number of days in hospital decreased as the PaedCTAS score increased ($p=0.000$). Additionally, by logistic regression, even with the covariates included in the model, the only variables which are associated with PaedCTAS are hospitalization and length of stay in the ED (Yates et al., 2016). Similarly, Gravel and colleagues showed that a longer LOS in the ED was noted for patients with more acute triage levels. The ANOVA showed a statistically significant relationship ($p < 0.001$) between treatment level and mean LOS. Patients tested for Level 2 had lower LOS than patients tested for Level 2 ($P < 0.001$), patients tested for Level 4 had lower LOS than patients tested for Level 3 ($P < 0.001$), and patients tested for Level 5 ($P < 0.001$) Patients) (Gravel et al., 2012). In another study, Grewal and colleagues suggested that patients tested at Level 1 should have longer stays in the ED than patients who underwent testing at Level 1 (Gravel et al., 2012). They concluded that 22% of patients tested at Level 1 were admissions into the ICU. These patients usually stay in the ED for a while because they are rapidly enrolled in the ICU and do not have to wait long to see a doctor.

Mortality was significantly associated with the P-SATS and PaedCTAS triage scores ($p= <0.001$). Mortality was observed mainly in patient who were primarily triaged with high acuity scores. All these observations support the effect of these scores in the proper allocation of the limited resources of the EDs to the patients who are really in a need of them. Dalwai et al. demonstrated that the P-SATS was able to accurately predict a significant increase in the likelihood of mortality moving from low to high acuity levels for patients with trauma and non-trauma patients, $p<0.001$ (Dalwai et al., 2018)

The validity of both scores was further evaluated by sensitivity and specificity in prediction of hospitalization, PICU admission, LOS and mortality. PaedCTAS performed better than P-SATS with AUC 0.968 vs 0.892, 0.976 Vs 0.848, and 0.697 Vs 0.593 in prediction of PICU admission, LOS and mortality, respectively in addition to comparable sensitivities. However, regarding the prediction of admission P-SATS performed better with an AUC of 0.849 compared to 0.804 of paedCTAS. Gouin et al. in 2011 reported low accuracy of paedCTAS to assess the need for admission with fewer subjects classified as urgently hospitalized (AUC = 0.69) (Augustyn et al., 2011). One explanation for that difference is that their threshold for admission is low. In addition, they may have further interventions and investigations in the ED by confirming a previous diagnosis or reducing symptoms, thereby reducing the admission rate.

We found that P-SATS sensitivity was 66.25% and specificity was 85.22% in predicting admission requirement. Reported comparable sensitivity in previous literature. Engan and colleagues found that the modified P-SAT had a moderate sensitivity of 74% (Engan et al., 2018). In Botswana, the Accident and Emergency Department of Princess Marina Hospital adopted the South African Triage Scale and created the PMHA & E Triage Scale (PATS) (Twomey et al., 2012). However, in 2013, Twomey M et al. The P-SATS Triage study was conducted at six different emergency centers in the Western Cape in South Africa, which has been found to be a powerful therapeutic tool for children with a sensitivity of 91% and a specificity of 54.5%, using hospital admission as an immediate marker (Twomey et al., 2013). This could be explained by differences in health care organization, the admission rates and study populations in addition to the huge sample size of Twomey et al. as it was a multicenter study. Another study conducted in the emergency department in Timergara hospital in Pakistan, the P-SATS had high specificity (97%) and moderate sensitivity (70%) (Mullan et al., 2014).

Reported the validity of the other 2 standard triage tools for children compared to other international pediatric triage tools. The ability of the Manchester Triage Scale (MTS) to identify actual emergencies defined by an expert panel was assessed by Rutschmann et al. in 2006. Based on a sample of 1,065 patients, they concluded that MTS has 63% sensitivity and 78% specificity for identifying true emergencies. In 2008, van Veen and others assessed the correlation between the level of treatment employed by the MTS and the independently predicted reference standard for 5 emergencies for 16,735 children who visited the same ED at 13 months. Their main conclusion is that children have moderate validity on the Manchester Triage Scale. In another study by Travers et al., the treatment level and hospitalization ratio (level 1 83%; level 2 46%; level 3 17%; level 4 17%; level 4 4%; level 5 5%) using resource ESI. consumption. Length of stay (Level 1 156 minutes; Level 2 236 minutes; Level 3 259 minutes; Level 4 117 minutes, Level 5 99 minutes) (Travers et al, 2010).

We may need some adjustments in both scores to suit our settings and resources. In their evaluation study, Engan and colleagues in the Department of Pediatric and Adolescent Medicine at the Hackland University Hospital in Bergen, Norway, as part of the implementation of P-SATS (Engan et al., 2018). The first TEWS tables were extended to two to six different age groups and improved with new data on age-specific normal values for respiration rate and pulse. In addition, a score for pulse oximetry was included and the score was removed for any injury. The revised variant of P-SATS categorizes patients into the triage category Red (Emergency), Yellow (Emergency), Orange (Very Emergency), Green (not Emergency) or Blue (White) (Westwood et al., 2013).

This study has the strength of being conducted prospectively and no patients were excluded or missed. We did not rely on chart review to find that the study was interrupted because it received a real-time assessment of ED performance during the study period. However, our study confronted a few restrictions which may affect our ability to generalize our findings. Firstly, it is a single-centre study, assessing only pediatric patients attending the Suez Canal University Hospital. Therefore, it is not perfectly representative of the general population. Further larger multicenter studies are needed. Secondly, there is no standard of care for treatment. Although intensity is associated with severity, it is not always so. Accordingly, hospital admissions, resource utilization, and length of stay may not fully reflect emergencies. However, the association with multiple markers of severity indicates that the treatment tool is sufficiently valid. Finally, over-triage and under-triage are key elements of treatment that were not evaluated in our study. Excessive treatment when we place too many children in the highest priority categories. Under-Triage when sick children are included in triage categories.

Conclusion

There was a good association between both triage scales' levels and multiple markers of severity of illness, suggesting that they have good validity. Both scales showed good prediction ability of the need for admission or PICU admission in addition to mortality. Thus, the scales are valid triage tools for children who present to an ED with paedCTAS being slightly more accurate than P-SATS.

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