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Original Article

Assessment of the patients' outcomes after implementation of South African triage scale in emergency department, Egypt

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ABSTRACT

Purpose: Overcrowding in emergency department (ED) is a concerning global problem and has been identified as a national crisis in some countries. Several emergency sorting systems designed successfully in the world. Launched in 2004, a group of branches in South African triage scale (SATS) developed. The effectiveness of the case sorting system of SATS was evaluated to reduce the patient's length of stay (LOS) and mortality rate within the ED at Suez Canal University Hospital.

Methods: The study was designed as an intervention study that included a systematic random sample of patients who presented to the ED in Suez Canal University Hospital. This study was implemented in three phases: pre-intervention phase, 115 patients were assessed by the traditional protocols; intervention phase, a structured training program was provided to the ED staff, including a workshop and lectures; and post-intervention phase, 230 patients were assessed by SATS. All the patients were retriaged 2 h later, calculating the LOS per patient and the mortality. Data was collected and entered using Microsoft Excel software. Collected data from the triage sheet were analyzed using the SPSS software program version 22.0.

Results: The LOS in the ED was about 183.78 min before the intervention; while after the training program and the application of SATS, it was reduced to 51.39 min. About 15.7% of the patients died before the intervention; however, after the intervention the ratio decreased to 10.7% deaths.

Conclusion: SATS is better at assessing patients without missing important data. Additionally, it resulted in a decrease in the LOS and reduction in the mortality rate compared to the traditional protocol.

Introduction

More than half of emergency department (ED) visits are non-urgent and do not require emergency care. The increasing number of patients visiting ED lead to crowdedness, long waiting time and a negative impact on patients' satisfaction. Yet, more importantly, it results in unnecessary costs and wastes the resources of the institution, and the time of physicians that would be otherwise directed to more serious cases. Thus, emergency physicians (EP) need to follow a systematic approach in order to prioritize the care of patients based on their clinical urgency.[1]

Triage is defined as the process of sorting patients based on the acuity of their condition.[2] When patients are sorted according to their immediate presentation, this ensures that severely ill or traumatized patients receive timely care before their conditions get worse. The decisions made in triaging may be based on both the patients' vital signs (heart rate, blood pressure, respiratory rate, oxygen saturation in blood, level of consciousness, and body temperature) and their main complaints.[2] An accurate triaging system is expected to decrease the mortality rates, reduce the length of stay (LOS), and prioritize the use of resources.[1]

The South African Triage Group developed a triage system in 2004 (Emergency Medicine Society of South Africa, 2010). The South African triage scale (SATS) has shown to speed up the delivery of timely care for patients with life-threating conditions, improve patients flow, facilitate the streaming of less urgent cases, and reduce the overall LOS. More importantly, the SATS overcomes the shortage of doctors and nurses in developing countries by enabling a wide range of healthcare providers to use it in the EDs.[3]

Several studies investigated the value of applying the SATS in developing countries. For example, a recent study evaluated the validity of SATS in Afghanistan, Haiti and Sierra Leone. The authors

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concluded that, in low-resource countries, SATS was valid for trauma-only settings. Nevertheless, in mixed-medical settings, the majority of "red" patients turned to be over-triaged, whereas most of non-trauma and all of the trauma "green" pediatric patients were under-triaged.[4]

Up to date, although several studies assessed the validity of SATS as a triaging tool in low-resource settings; however, as far to our knowledge, none of these studies was conducted in Egypt. Moreover, there is no formal triage system that is adopted by the healthcare system in Egypt. Many individual non-organized trials to train physicians on different emergency medicine topics have been carried out but still physicians and health team personnel face many challenges in updating their knowledge.[5] Hence, there is a great necessity for a powerful triage system to be applied in our country as a region-providing healthcare in low-resource settings.

The traditional Suez Canal University Hospital (SCUH) protocol is not dependable on triage system but mainly on personal experiences of physicians and paramedical staff on duties who may be EP or even not EP and do not know triage system at all. There is even no triage room, and triage is not applied in our hospital. So, what we do? We try to apply the best and easy method for initial management and disposition according to the initial physician decision with low-resource ED sittings.

Concerning SCUH, the ED is one of the busiest departments at the hospital providing care for all kind of cases, including road traffic injury victims and patients with medical, surgical, obstetrics or pediatric emergencies. Moreover, it provides emergency care service for the inhabitants of 5 governorates in Egypt; therefore, it is usually crowded with patients and their families. The increasing number of patients presenting to ED necessitates applying an efficient triage system in order to stop wasting resources and provide the best care for patients in need within the ideal time. Furthermore, it shall help to attain patients' trust and boost patients' satisfaction.

Therefore, out of the above-mentioned reasons, this study aimed to evaluate the effectiveness of the case sorting system by assessing the patients' outcomes after the implementation of SATS in the ED at SCUH in terms of the LOS and the mortality rates, compared to the traditional triage strategy.

Methods

Setting of the study

The study was conducted at the ED at SCUH, Ismailia, Egypt. The ED at SCUH is a 50-bed unit divided into general assessment area, trauma yard, observational rooms and 8-bed unit as a resuscitation room, working 3 days per week (Saturday, Monday and Wednesday). During the other 4 days, emergency patients are directed to Ismailia General Hospital unless a major traumatic accident or a disaster occurs. The estimated ED visit volume is around 400 patients per day.

Study population

The study included all patients presenting to the ED in SCUH. Inclusion criteria: (1) all adult patients of both sexes at the general assessment area, resuscitation, and observation rooms; (2) all patients in the trauma area, including pediatrics. Exclusion criteria: (1) patients refusing to participate in the study; (2) non-traumatic pediatric and obstetric patients as they follow a separate path in the ED where they are directly received and managed by the pediatricians and obe/gynecologists, respectively; (3) patients triaged as green according to SATS category; (4) patient triaged as blue according to SATS category.

Study aims

The study aim is to improve the quality of emergency care service in the ED at SCUH through implementation assessment of a new assessment strategy (SATS).

Primary objective: to assess the patients' outcomes after the implementation of SATS in ED at SCUH, in terms of the LOS and the mortality rates in ED.

Secondary objective: to assess the rate of under- and over-triaging in the ED while using the SATS.

Study question: Would the implementation of the SATS in the ED reduce patients' LOS and mortality rate?

Sample size

The sample size was calculated according to the following formula based on data from previous study[6]:

$$n = \frac{\delta^2 (Z_\alpha + Z_\beta)^2}{D^2}$$

δ = Standard deviation of the outcome = 152
Z_α = Z value for a type I error of 5% = 1.96
Z_β = Z value for a type II error of 10% = 1.28
D^2 = The effect size = 46

According to the above formula, the sample size in the pre-intervention phase was 115 participants and in the post-intervention phase was 230 participants. The total sample size was 345.

Sampling method

A systematic sampling method was used in which every third patient presenting to the ED was enrolled. This study was conducted in three phases: pre-intervention, intervention, and post-intervention phases.

The pre-intervention phase (1 month): the already followed system continued; according to which, patients' triage was made based on the physician clinical judgment after the initial airway, breathing, circulation, disability and exposure (ABCDE) assessment, vital signs recording and history taking. The LOS and mortality rate was recorded.

Outcome measures

LOS is the time interval from patient's registration to discharge. Discharge of the patient was defined as the time when the patient finished his treatment in the ED and was transmitted from the ED to the operation room or to the internal wards. This was reported in minutes.

Mortality rate refer to number of patients who deteriorated to death in the ED over the whole number of patients who attended the ED at the same day. It was counted as long as the patient is still in the ED.

Intervention phase (two settings)

This comprised the structured intervention training program and held during the monthly scientific day of the ED of SCUH. The ED staff, including physicians and nurses, attended a structured training on the triage. This included an interactive lecture using a Power Point presentation, and a workshop with case-scenarios. Visual aid as brochures and posters were prepared and made available for the participants.

The lecture was interactive using a Power Point presentation and presented the theoretical information about the triage process, including the general principles of triage and the details of SATS. The workshop was conducted following the lecture to drive the participants to put the theory into action and enable them to practice the triage using SATS on sample cases. Brochures were handed to all ED physicians and nurses. Posters were hanged on the walls of the department constantly to remind the staff with the newly gained knowledge and act as an available guide to turn into during the actual practice.

Post-intervention phase

Following the training program, physicians and nurses were encouraged to apply what they learnt and triage the patients according to the SATS. For every enrolled patient, the triage early warning score (TEWS) was calculated and his/her emergency ticket was marked using a sticker with the triage colour according to TEWS. Patients received the appropriate care according to their TEWS. Then, re-triaging to the patient as yellow, orange and red colours was done 2 h later as the total LOS of the patients in ED should not exceed 6 h. The following items were assessed during re-triaging: (1) the primary triage that was done once the patient attended the ED; (2) the progress of the patient clinical status determined by the colour that was assigned to him/her during the secondary assessment

SATS

We used the adult version of SATS (Appendix 1). The method for adult triage is:

(1) Take a brief history.
(2) Assess mobility.
(3) Measure the vital signs and record the discoveries:
- Place thermometer in axilla.
- Attach blood pressure sleeve and begin estimation (electronic or advanced).
- Count 30 s of breaths and two-fold the answer.
- Check heart rate and systolic pulse perusing (or measure these at this point if manual blood pressure sleeve).
- Take thermometer out and check temperature.

(4) Assess alert, voice response, painful response and unresponsive (AVPU).
(5) Calculate the aggregate TEWS and record the finding.
(6) Match the TEWS to a triage need (red, orange, yellow, and green).
(7) Check the discriminator list for any issues that will dole out the patient a higher triage classification.
(8) Document the last triage classification.
(9) Check the triage intervention notice for any important mediation.

The TEWS classified patients as follows:
Red: take to the resuscitation room for emergency management.
Orange: refer to majors for very urgent management.
Yellow: refer to majors for urgent management.
Green: refer to designated area for non-urgent cases (primary health care/outpatient clinic).
Blue/Black: dead, refer to doctor for certification.
There is summarized chart for emergency patients as in Appendix 1.

Vital signs, mobility, level of consciousness by AVPU score and the presence of trauma recorded in a triage form. TEWS manually calculated at once and then the recommended decision followed. The LOS and the mortality rate were assessed.

A triage form was used to obtain the data of every enrolled patient. This form includes their demographic characteristics, TEWS, the emergency management, TEWS after re-triaging, and the LOS.

Date management and statistical analysis

Data was collected and entered using Microsoft Excel software. Collected data from the Triage sheet were analyzed using the SPSS software program version 22.0. Continuous data (age, LOS at ED, heart rate, blood pressure, etc.) were expressed as mean ± SD; whereas categorical data like gender, education, marital status, etc. were expressed as frequency and percentage. Data was presented as tables and graphs. *t*-test was used to compare between quantitative data (independent *t*-test for two unpaired variables and the dependent *t*-test for two paired variables), while Chi-square was used to compare between the qualitative data, whenever compatible. One-way ANOVA (analysis of variance) was used in comparing 3 or more parametric data groups. For non-parametric, we used Kruskal-Wallis test. For the relation between 2 quantitative variables, we used Pearson correlation. Regression was used to identify the predictors of outcomes (LOS and mortality rate). Results were considered statistically significant at a p value less than 0.05 and highly significant at a p value less than 0.01.

Results

The present study was designed as a pre- and post-intervention study that every 3rd patient was enrolled in the study who presented to the ED in SCUH. This study aimed at assessing the patients' outcomes after the implementation of SATS in the ED at SCUH in terms of their LOS and the mortality rates compared to the traditional triage strategy.

In this study, the baseline characteristics of the studied sample were summarized (Table 1). Two thirds of the patients in SATS group were males (66.1%); while males formed 56.5% of the patients in the traditional score. There was no statistically significant difference between patients in the two groups in any of the baseline characteristics.

Table 1
Baseline characteristics of the studied sample.

Variables	Assessment tool		p value
	SATS ($n = 230$)	Traditional ($n = 115$)	
Age (years), mean ± SD	46.75 ± 21.59	43.04 ± 21.19	0.15[a]
Gender, n (%)			
Male	152 (66.1)	65 (56.5)	0.08[b]
Female	78 (33.9)	550 (43.5)	
Marital status, n (%)			
Single	83 (39.5)	34 (33.7)	0.32[b]
Married	127 (60.5)	67 (66.3)	

[a] p values are based on Mann Whitney U test. Statistical significance at $p < 0.05$.
[b] p values are based on Chi-square test. Statistical significance at $p < 0.05$.
SATS: South African triage score.

Our study revealed the TEWS items of patients in both strategies (Table 2). It found that assessment by traditional triage strategy was significantly associated with higher frequency of incomplete points in all TEWS items. For example, more than 70% of the cases had deficient assessment regarding to their heart rate (77.4%), temperature (72.2%) and AVPU (78.3%). Moreover, 95.7% of the patients did not have their respiratory rate assessed.

In Table 3, the comparison of TEWS outcomes of patients among SATS group, the average time taken to undergo triage among patients in SATS group was (7.65 ± 2.87) min, while the mean TEWS total score of the group was (3.19 ± 2.33) points. About one-half of the patients had green colour (47%) while about one quarter of them took orange colour (27%).

Our study assessed the primary triage among SATS group (Table 4), which revealed more than 76% of the patients were appropriately evaluated during the process of triage using TEWS. Similarly, about one-half of the patients had green colour (48.3%) as secondary triage assessment.

The results revealed in Table 5 that assessment by traditional triage strategy was significantly associated with higher frequency of incomplete assessment in AVPU item ($p < 0.001$), where more than 78.3% of the cases had deficient assessment (90 patients).

Table 2
Triage early warning score items of patients in both groups.

Variables	Assessment tools *n (%)*		*p* value
	SATS (*n* = 230)	Traditional (*n* = 115)	
Mobility			
Walking	82 (35.7)	16 (13.9)	<0.001[a]
With help	115 (50.0)	18 (15.7)	
Stretcher/immobile	33 (14.3)	11 (9.6)	
Not assessed	0 (0)	70 (60.9)	
RR (breathes/min)			
<9	4 (1.7)	3 (2.6)	<0.001[a]
9–14	177 (77.0)	2 (1.7)	
15–20	49 (21.3)	0	
Not assessed	0 (0)	110 (95.7)	
HR (beats/min)			
<41	4 (1.7)	3 (2.6)	<0.001[a]
51–100	149 (64.8)	7 (6.1)	
101–110	43 (18.7)	3 (2.6)	
111–129	31 (13.5)	8 (7)	
>129	3 (1.3)	5 (4.3)	
Not assessed	0 (0)	89 (77.4)	
SBP (mm Hg)			
<71	5 (2.2)	4 (3.5)	<0.001[a]
71 – 80	27 (11.7)	11 (9.6)	
81 – 100	49 (21.3)	10 (8.7)	
101 – 199	121 (52.6)	49 (42.6)	
>199	28 (12.2)	16 (13.9)	
Not assessed	0 (0)	25 (21.7)	
Temperature (degree)			
Cold (<35)	4 (1.7)	0 (0)	<0.001[a]
35–38.4	186 (80.9)	19 (16.5)	
Hot (>38.4)	40 (17.4)	13 (11.3)	
Not assessed	0 (0)	83 (72.2)	
AVPU			
Confused	33 (14.3)	14 (12.2)	<0.001[a]
Alert	186 (80.9)	7 (6.1)	
Response to voice	6 (2.6)	3 (2.6)	
Response to pain	1 (0.4)	0 (0)	
Unresponsive	4 (1.7)	1 (0.9)	
Not assessed	0 (0)	90 (78.3)	

[a] *p*-values are based on Fisher Exact test. Statistical significance at $p < 0.05$.
SATS: South African triage score; RR: respiration rate; HR: heart rate; SBP: systolic blood pressure; AVPU: assess alert, voice response, painful response and unresponsive.

Table 3
Comparison of TEWS outcomes of patients among SATS group.

Variables	SATS (*n* = 230)
Time to triage (min), mean ± SD	7.65 ± 2.87
TEWS total score, mean ± SD	3.19 ± 2.33
TEWS colour, *n* (%)	
Green	108 (47.0)
Yellow	37 (16.1)
Orange	62 (27.0)
Red	19 (8.3)
Blue (dead)	4 (1.7)

SATS: South African triage score; TEWS: triage early warning score.

Table 4
Assessment of primary triage using TEWS among SATS group.

Variables	*n* (%)
Evaluation of primary triage	
Appropriate	176 (76.5)
Over-triage	20 (8.7)
Under-triage	34 (14.8)
Secondary TEWS colour	
Green	111 (48.3)
Yellow	41 (17.8)
Orange	50 (21.7)
Red	22 (9.6)
Blue (dead)	6 (2.6)

SATS: South African triage score, TEWS: triage early warning score.

Table 5
Evaluation of ABCDE approach of patients in both groups.

Variables	Assessment tools		*p* value
	SATS (*n* = 230)	Traditional (*n* = 115)	
Airway, *n* (%)			
Maintained	224 (97.4)	111 (96.5)	0.9[a]
Not maintained	6 (2.6)	4 (3.5)	
Breathing, *n* (%)			
Self-breathing	189 (82.2)	88 (76.5)	0.21[b]
Oxygen mask	41 (17.8)	27 (23.5)	
Circulation, *n* (%)			
Normal	193 (83.9)	92 (80)	0.36[b]
Fluid challenge	37 (16.10	23 (20)	
AVPU, *n* (%)			
Confused	33 (14.3)	14 (12.2)	<0.001[a]
Alert	186 (80.9)	7 (6.1)	
Response to voice	6 (2.6)	3 (2.6)	
Response to pain	1 (0.4)	0 (0)	
Unresponsive	4 (1.7)	1 (0.9)	
Not assessed	0 (0)	90 (78.3)	
GCS, mean ± SD	13.45 ± 2.06	12.7 ± 2.11	0.1[c]

[a] *p* values are based on Fisher Exact test. Statistical significance at $p < 0.05$.
[b] *p* values are based on Chi-square test. Statistical significance at $p < 0.05$.
[c] *p* values are based on Mann Whitney *U* test. Statistical significance at $p < 0.05$.
ABCDE: airway, breathing, circulation, disability and exposure; SATS: South African triage score; AVPU: assess alert, voice response, painful response and unresponsive, GCS: Glasgow coma scale.

Our study revealed the patients' destination in each triage strategy in Table 6. Thirty-seven percent of the patients evaluated by SATS were discharged from ED based on their TEWS score. Moreover, about one quarter of the patients admitted in intensive care unit (ICU)/coronary care unit (CCU) (26.5%). On the other hand,

Table 6
Evaluation of ABCDE approach of patients in both groups.

Variables	Total ($n = 345$)	Assessment tools *n (%)*		*p* value
		SATS ($n = 230$)	Traditional ($n = 115$)	
Disposition				0.009[a]
Inpatient admission	62 (18)	40 (17.4)	22 (19.1)	
ICU/CCU admission	77 (22.3)	61 (26.5)	16 (13.9)	
Transferred	4 (1.2)	2 (0.9)	2 (1.7)	
Discharged	137 (39.7)	85 (37)	52 (45.2)	
Died at ED	37 (10.7)	19 (8.3)	18 (15.7)	
Underwent surgery	28 (8.1)	23 (10)	5 (4.3)	

[a] *p* values are based on Fisher Exact test. Statistical significance at $p < 0.05$.
ABCDE: airway, breathing, circulation, disability and exposure; SATS: South African triage score; ICU: intensive care unit; CCU: coronary care unit; ED: emergency department.

about one-half of the patients assessed by traditional strategy discharged from ED (45.2%) and about 19% of the patients admitted in the inpatient ward. Patients' disposition differed significantly between the two groups ($p = 0.009$).

Our study revealed in Table 7 those patients in the SATS group had significantly shorter LOS (min) 51.39 ± 27.91 than patients who were assessed by traditional strategy (183.78 ± 93.51, $p < 0.001$). Moreover, SATS triage strategy was associated with a lower mortality rate compared to the traditional triage strategy ($p = 0.043$).

Table 8 shows logistic regression analysis used to assess predictors of patients' survival attending ED. It was found that the odds of patients' survival increase by 2.06 times when they were assessed using SATS compared to patients who were assessed by traditional triage score ($OR = 2.06$, 1.036–4.101, $p = 0.039$).

Table 9 shows linear regression analysis used to assess predictors of hospital stay length among patients attending ED. R2 = 0.627, where 62.7% of the variability of hospital stay length among emergency patients can be explained by this linear model. We found that using SATS tool to assess patients was significantly associated with less hospital stay length ($p < 0.001$). To illustrate, there was a decrease by 132.4 min in the LOS for patients who were assessed using SATS compared to patients who were evaluated by traditional triage score ($\beta = -132.4$, -143.23 to -121.55, $p < 0.001$).

Table 8
Logistic regression analysis of determinants of patient survival.

Predictors	*β*	SE	OR (95% *CI*)	*p* value
Constant	1.68	0.257		<0.001
Assessment tool				
SATS *vs.* traditional (R)	0.723	0.351	2.06 (1.036–4.101)	0.039[a]

[a] Statistical significance at $p < 0.05$.

Discussion

Overcrowding in the EDs is a concerning global problem, and has been identified as a national crisis in some countries. Overcrowding of EDs is defined as “the situation in which ED function is impeded primarily because the excessive number of patients waiting to be seen, undergoing assessment and treatment, or waiting for departure comparing to the physical or staffing capacity of the ED”. Patients’ safety and privacy, timeliness of the services, and frustration among ED staff should be considered in the studies of overcrowding in EDs.[7,8]

To alleviate the problem of ED overcrowding, different solutions were proposed by researchers, such as input-throughput-output conceptual model of ED crowding, increasing the resources, demanded management, operation research, lean thinking, chest pain observation units, rapid assessment zones, and clinical decision units. Lean healthcare thinking led many of the new strategies to redesign the optimal pathways, contributing value steps, and deleting no value steps. In order to decrease the LOS in ED, health authorities have introduced 4-h target. Despite previous efforts, limited scientific knowledge on how to improve patient flow in ED has been achieved.[9]

SATS was developed to enable the triage of patients in the EDs and is used by Médecins Sans Frontières in low-resources settings.[10–12]

The need for triage systems was recognized in low-resource settings with reports demonstrating that the triage process can improve patient flow, decrease patient waiting time, and reduce mortality in these perspectives.[13,14] SATS category, patient age, and reason for admission can be used to predict in-hospital mortality.[15]

The present study was designed as a pre-post intervention study that included all patients who presented to the ED in SCUH. This study aimed at assessing the patients' outcomes after the implementation of SATS in ED at SCUH in terms of the LOS and the mortality rates compared to the traditional triage strategy.

Table 7
Comparison of length of stay and mortality rate of patients in both groups.

Variables	Total ($n = 345$)	Assessment tools		*p* value
		SATS ($n = 230$)	Traditional ($n = 115$)	
Length of stay (min), mean ± SD	95.39 ± 78.77	51.39 ± 27.91	183.78 ± 93.51	<0.001[a]
Mortality rate, *n* (%)				0.043[b]
Died	37 (10.7)	19 (8.3)	18 (15.7)	
Survived	308 (89.3)	221 (91.7)	97 (84.3)	

[a] *p* values based on Mann Whitney *U* test. Statistical significance at $p < 0.05$.
[b] *p* values based on Fisher Exact test. Statistical significance at $p < 0.05$.
SATS: South African triage score.

Table 9
Linear regression analysis of determinants of length of hospital stays.

Predictors	Unstandardized coefficients		Standardized coefficients beta	(95% *CI*)	*p* value
	β	Std. Error			
Constant	316.2	9.55			<0.001[a]
Assessment tool					
SATS *vs.* traditional (R)	−132.4	5.51	−0.793	(−143.23) − (−121.55)	<0.001[a]

ANOVA<0.001, $R^2 = 0.627$.
[a] Statistical significance at $p < 0.05$.

We found that before intervention, variables such as mobility, respiration rate, heart rate, systolic blood pressure, temperature, APVU were missed during the assessment of the patients by the traditional strategy; while after applying the SATS triage system, we found that the rate of missed variables was reduced to almost zero. Similarly, a study reported that without using the SATS, there was poor documentation in many fields, and the confirmed time to treatment was within recommended timescales for only 48% of patients. This would be the fact that SATS provides an assessment sheet that contains all the variables, which helps the health care providers to document all of them. This was reported by many studies.[16]

Even by applying ABCDE before intervention, documentation of the AVPU item was missed, and more than 78% of cases had deficient assessment and documentations.

We found that patients in SATS group had an average time triage of about 7.65 min, which is shorter than the recommended waiting times for patients in the ED. This indicates the advantage and the importance of implementing SATS. On the other hand, a study found that the mean waiting time from triage until the patient was seen by the doctor was 2 h after implementing SATS.[17] However, it is still in the acceptable limit.

Patients' disposition differed significantly between the two groups ($p = 0.009$). Before intervention, about one-half of the patients who were assessed by the traditional strategy were discharged from the ED (45.2%) and about 19% of the patients were admitted in the inpatient ward. While after intervention, 37% of the patients who were evaluated by SATS were discharged from the ED based on their TEWS score. Moreover, about one quarter of the patients were admitted in the ICU/CCU (26.5%) with applied SATS but in traditional methods were only 13.9% because SATS gives high chance for good sorting of patients who attended to ED and resuscitation room, and also we applied ICU triage for selection of critical cases who mostly induced over-triage for improved ICU outcome. Similarly, a study reported that overall over-triage rates improved from 53% (pre-SATS) to 38% (SATS) ($p < 0.001$); likewise, under-triage rates improved from 47% (pre-SATS) to 16% (SATS) ($p < 0.001$). Statistically significant decreases in both rates were found when pediatric and adult cases were analyzed separately. SATS was more predictive of inpatient admission, ICU admission and death rates in the accident and emergency than was the pre-SATS.[18] This is probably due to the efficacy of the triage system to detect more severely injured patients.

Before the intervention, the LOS was about 183.78 min while after the application of SATS the LOS was reduced to 51.39 min, which shows that the patients in SATS group had significantly shorter LOS. Similarly, Bruijns and his colleagues[14] found that the waiting time significantly reduced in all but the lowest priority category. The introduction of nurse triage using the Canadian triage scale resulted in an overall reduction in waiting time from 237 min to 146 min ($p < 0.001$).

To illustrate, the LOS for patients decreased by 132.4 min in patients who were assessed by SATS in comparison to the patients who were evaluated by the traditional methods ($p < 0.001$). Similarly, the introduction of nurse triage using the SATS resulted in an overall reduction in waiting time from 237 min to 146 min ($p < 0.001$).[14] Moreover, with applied SATS rather than traditional methods resulted in a dramatic and fascinating decrease for LOS because SATS gave high chance for good sorting of patients who attended to ED and resuscitation room, and also we applied ICU triage for selection of critical cases who mostly induced over-triage for improved ICU outcome and gave rapid and proper management in proper time without delay treatment interventions.

Before intervention, about 15.7% of the patients died; while after the intervention, the ratio decreased to 10.7% of the patients. This is probably due to increased attention paid to the vital signs of the patients after implementing SATS system. Moreover, the odds of patients' survival increased by 2.06 times when they were assessed using SATS compared to patients who were assessed by the traditional strategy. On the other hand, a study reported that there was no change in death rate between the pre-SATS and SATS, but ICU admission rates decreased from 0.35% to 0.06% ($p < 0.001$).[18] This discrepancy in results may be attributed to the quality of care provided by the hospital after triaging patients. As it is not enough to triage patients when there are no resources to treat them as clarified by Chaou and his colleagues.[19]

Strengths

This is considered the first study to assess the effectiveness of SATS at SCUH.

The same doctors and nurses applied both types of triage (SATS and traditional).

With applied SATS, there was improvement because staff had received a teaching programme on the importance of vital signs in triage.

Limitations

There was little time to train doctors and nurses to apply the SATS triage in the ED.

There were low ED sittings for monitors to rapid assess vital signs, so in pre-intervention phase many vital signs did not measure.

The study was done in one hospital, so the results cannot be generalized, and further studies are needed.

Recommendations

(1) South African triage scale is a suitable assessment strategy to use in Egypt and other developing countries for its ease of application and conduction in emergency centers.
(2) Multiple sessions and educational programs for health care providers about how to use SATS will probably improve the outcomes.

(3) Further studies need to be conducted in this field to establish the effectiveness of SATS.
(4) Multicenter studies should be conducted to compare the results of multiple areas.
(5) Further studies need to be conducted about other different triaging systems that might be available to be conducted and established in the developing countries.

Conclusion

The study emphasizes the importance of the application of the screening system as it has a significant role in reducing the number of deaths. It found that SATS was better at assessing patients without missing important data, and also, it showed reduction in LOS and mortality rate compared to the traditional strategy that usually depends on emergency physicians' experts and the patient's presentation at the time of arrival to the emergency theatre.

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Ethical statement

SCUH approval was requested before commencing the study. A written informed consent was got from all the participants. For the participants from age 12 years old until 18 years, an informed consent from the participant himself in addition to the parents' consent was obtained. All the obtained data were kept confidential and were not used outside this study without patients' approval. Patients were informed that they are free to withdraw from the study at any time without giving any explanation.

Declaration of competing interest

All authors declare that they have no competing interests (financial or non-financial).

Author contributions

Adel Hamed Elbaih carried out the study conception and design, participated in its design and coordination and drafted the manuscript. Ghada Kamal Elhadary carried out the design of the study, the analysis and interpretation of data and helped to draft the manuscript. Magda Ramdan Elbahrawy participated in the sequence alignment, interpretation of data and drafting of manuscript. Samar Sami Saleh carried out the study conception and design, participated in its design. Adel Hamed Elbaih participated analysis and interpretation of data and helped to draft the manuscript. Samar Sami Saleh participated by acquisition of data and performed the statistical analysis. All authors read and approved the final manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cjtee.2021.10.004.

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