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Comparison of triple triage system and CTAS (Canadian Triage and Acuity Scale) system in the emergency department

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Ethics Committee Approval
The study was approved by the Istanbul Medipol University Ethics Committee on June 29, 2021 with decision number 765.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

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Abstract

Background/Aim: Triage systems are crucial for determining patient care priorities and efficiently utilizing resources in emergency departments. The aim of this study is to compare the effectiveness of the three-stage triage system (TR) and the Canadian Triage and Acuity Scale (CTAS) system in terms of patient safety, resource management, and alignment with expert opinions in an adult emergency department.

Methods: A prospective, cross-sectional, single-blind clinical study was conducted in an adult emergency department between October 1 and October 15, 2021. Patients aged 15 years and older with a Glasgow Coma Scale (GCS) score of 15 were included in the study. Trauma patients, patients transported by ambulance, and patients under 15 years of age were excluded from the study.

CTAS was applied by a single emergency medicine resident on odd days of the month, while TR was applied on the even days. The specialist physician who provided the reference triage categories was unaware of the initial assessments. Primary outcomes included inter-rater agreement (weighted kappa coefficient), triage accuracy, and resource utilization patterns. Statistical analysis used the Kruskal-Wallis H test, Fisher's exact test, and a weighted kappa coefficient with a significance level set at $P<0.05$.

Results: A total of 620 patients were evaluated (TR: n=290, CTAS: n=330). CTAS demonstrated significantly higher agreement with expert opinion compared to TR ($\kappa=0.375$, $P<0.001$) ($\kappa=0.835$, $P<0.001$). In CTAS, the rate of inadequate triage was significantly lower (12%) compared to TR (28%). CTAS demonstrated a more balanced patient distribution across emergency levels and rational resource utilization, resulting in appropriate requests for radiological examinations at T3 level (32.35% compared to 78.95% in the yellow zone of TR, $P<0.001$). Hospital admission rates were higher in CTAS (seven patients) compared to TR (one patient).

Conclusion: The CTAS system demonstrated significantly higher compliance and lower triage error rates compared to the TR system, with expert consensus, thereby showing superior performance in terms of patient safety and resource management. The implementation of CTAS in emergency departments may improve the quality of patient care and optimize resource utilization.

Keywords: CTAS Emergency, TR, Triage

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Introduction

Triage in emergency departments is crucial for determining the priority of patient care and efficiently utilizing resources [1,2]. Due to increasing patient volumes and limited resources, the use of an accurate and reliable triage system has become increasingly important [3].

Among the triage systems widely used worldwide are the three-phase triage system (TR), the Australian Triage Scale (ATS), the Manchester Triage System (MTS), the Emergency Severity Index (ESI), and the Canadian Triage and Acuity Scale (CTAS) [4,5]. Each system has its own advantages and disadvantages. The TR triage system is preferred for its simplicity and quick implementation, while its five-point system provides a more detailed assessment [6,7].

CTAS is an internationally recognized triage system developed in Canada in the late 1990s [8]. Its reliability and validity have been studied in many countries, with high agreement rates reported [9,10]. CTAS has been shown to be particularly successful in predicting patient outcomes and resource utilization [11,12].

The TR system is widely used, particularly in developing countries and busy emergency departments [13]. Its main advantages include simplicity, ease of understanding, minimal training requirements, and rapid implementation. However, insufficient detail in patient assessment and low triage risk are considered disadvantageous [14].

Studies comparing triage systems have generally focused on the reliability, validity, and resource utilization of the systems [15]. In recent years, with the increasing importance of patient safety, the rates of inadequate triage and overtriage have also been closely examined [16]. Inadequate triage refers to the low-priority assessment of high-risk patients, while overtriage refers to the high-priority assessment of low-risk patients [17].

The aim of this study was to compare the effectiveness of the TR and CTAS triage systems in an adult emergency department in terms of patient safety, resource management, and compliance with expert opinions.

Materials and methods

Study Design and Population:

This prospective, cross-sectional, single-blind clinical study was conducted in the adult emergency department of Haydarpaşa Numune Training and Research Hospital. Ethical approval was obtained from the Istanbul Medipol University Ethics Committee on June 29, 2021 with decision number 765. The study was conducted between October 1 and October 15, 2021, from 8:00 a.m. to 5:00 p.m. A total of 10,833 patients who presented to the emergency department during the study period were evaluated, of whom 3,136 were patients who presented during the specified hours.

Inclusion and Exclusion Criteria: Patients with a Glasgow Coma Scale (GCS) score of 15, aged 15 years or older, and who consented to participate in the study were included. Trauma patients, patients transported by ambulance, medical cases under the age of 15, and patients who refused to participate in the study were excluded.

Application Protocol

Triage assessments were performed by a single emergency medical technician trained in both triage systems. The CTAS triage system was applied on odd days of the month (1, 3, 5...), and the TR triage system was applied on even days (2, 4, 6...).

The specialist physician assigning the reference triage category was not informed of the initial triage assessment performed by the assistant. Vital signs and clinical assessments were performed using standard protocols.

Clinical Assessment Parameters

- Pulse: 60–100 beats/minute (normal range)
- Respiratory rate: >20/min considered abnormal
- Body temperature: 36–37.5°C (normal range)
- Oxygen saturation: <95% abnormal for TR system, <92% abnormal for CTAS
- Pain assessment: 1–3 (mild), 4–7 (moderate), 8–10 (severe)

Oxygen saturation measurements were performed using the MD300C2 finger-type pulse oximeter device manufactured by Beijing Choice Electronic Technology Co., Ltd. (Beijing, China).

Data Collection and Evaluation

Demographic information, clinical complaints, applied triage system, triage category, laboratory and imaging tests, consultation requirements, treatment methods, and discharge status from the emergency department were recorded using a standard data collection form. Patient admission complaints were classified according to the clinical categories provided in Table 1.

The final treatment and follow-up category was determined by an independent specialist physician based on a comprehensive patient assessment, final diagnosis, and actual status (discharge, admission to the ward, admission to the intensive care unit). This served as the reference standard for measuring triage accuracy.

After patients were discharged from the emergency department, the triage categories determined by the triage physician and the specialist physician were compared using a weighted kappa coefficient. Differences between the final treatment area category and the initial triage category were classified as “overtriage” and “undertriage.”

Triage Accuracy Assessment

Overtriage: The triage category assigned during the initial assessment is higher (more urgent) than the final treatment and follow-up area category.

Undertriage: The triage category assigned during the initial assessment is lower (less urgent) than the final treatment and follow-up area category.

Statistical analysis

SPSS version 23 (SPSS Inc., Armonk, NY) software was used for statistical analysis. For the comparison of TR and CTAS levels, the Kruskal-Wallis H test, a non-parametric test, was applied with post-hoc analysis using the adjusted Dunn test. Fisher's exact test was used to evaluate the relationships between categorical variables. The weighted kappa coefficient was calculated to evaluate the agreement of triage systems with expert consensus. The statistical significance level was set at $P<0.05$.

Results

Demographic Characteristics and Triage Distribution

A total of 620 patients were evaluated in the study. The TR group included 290 patients (mean age 44.60 [19.06], 57.93% female) and the CTAS group included 330 patients (mean age 46.61 [19.63], 52.73% female).

In the TR triage system, most patients were classified as green code (86.55%, n=251), while fewer patients were classified as yellow (12.07%, n=35) and red (1.38%, n=4) categories. In contrast, the CTAS system showed a more balanced distribution of emergency levels: T5 Non-urgent (58.79%, n=194), T4 Non-urgent (20.00%, n=66), T3 Urgent (17.27%, n=57), T2 Urgent (3.03%, n=10), and T1 Resuscitation (0.91%, n=3) (Table 2).

Gender distributions were similar across triage categories in both systems. In the TR system, patients in the yellow category were significantly younger than those in the green category (P<0.001), while no significant age differences were observed between categories in the CTAS system.

The five most common complaints in both systems were muscle pain, ENT issues, extremity problems, abdominal pain, and eye problems; detailed distributions are presented in Table 3.

Triage Consistency and Accuracy

The CTAS system demonstrated significantly higher consistency compared to the TR system when compared to expert opinion (κ=0.375, P<0.001) (κ=0.835, P<0.001). In the TR system, 80 of the 251 patients initially classified as green were upgraded to yellow following expert review, indicating significant inadequacy in triage (Table 4). In the CTAS system, only 34 of the 194 patients classified as T5 were revised to T4, demonstrating superior accuracy (Table 5). The triage deficiency rate in the TR system (28%) poses a significant patient safety concern compared to CTAS (12%).

This difference highlights the superior reliability of the CTAS system in accurately determining patient urgency levels.

Resource Utilization Models

Analysis of examination request patterns revealed that CTAS demonstrated a more rational approach to resource utilization. In the CTAS system, radiological examination requests for T3 emergency patients were significantly higher than other levels (78.95; P<0.001), while consultation requests were appropriately lower at the T5 level compared to higher urgency levels (P<0.001).

In the TR system, fewer laboratory tests were requested for yellow-coded patients than expected (P<0.001), while more consultation requests were made for red-coded patients (P=0.01). In CTAS, laboratory tests showed an appropriate distribution without significant differences across all levels (P=0.82) (Table 6).

Clinical Outcomes

In terms of patient discharge, 319 patients were discharged, seven patients were admitted, two patients were transferred, and two patients refused treatment in the CTAS group. In the TR group, 287 patients were discharged, one patient was admitted, and two patients refused treatment. The higher admission rate in the CTAS group indicates that patients requiring inpatient treatment were identified more effectively.

Table 1: Complaints of patients included in the study

Abscess and local infection	**Muscle pain**
Headache	ENT problems
Dizziness	Eye problems
Skin problems	Abdominal pain
Palpitations	Bites and stings
Dyspnoea	Vomiting diarrhea
Extremity problems	Syncope
Chest pain	Urinary problems
Pregnancy-gynecological problems	Psychiatric problems
Neurological conditions	GI bleeding-diabetes

ENT problems: Ear, nose and throat problems, GI bleeding: Gastrointestinal bleeding

Table 2: Gender and age characteristics of TR and CTAS groups

System/Category	Female n(%)	Male n(%)	χ^2; P_1	Age, years Median (IQR)	χ^2; P_2
TR					
Emergent	2 (50)	2 (50)	2.02; 0.404	38.00 (9.25-45.75)[a*b]	13.94; 0.001
Urgent	24 (68.57)	11 (31.43)		32.00 (17.00-46.00)[b]	
Standard	142 (56.57)	109 (43.43)		45.00 (31.00-61.00)[a]	
CTAS					
Resuscitation	1 (33.33)	2 (66.67)	1.07; 0.923	22.00 (22.00-67.00)*	6.94; 0.074
Emergent	5 (50)	5 (50)		59.50 (43.75-79.00)	
Urgent	28 (49.12)	29 (50.88)		48.00 (25.00-60.50)	
Less Urgent	36 (54.55)	30 (45.45)		42.00 (29.00-60.25)	
Non-Urgent	104 (53.61)	90 (46.39)		48.00 (31.75-61.25)	

*Categorical data presented as number and percentage, continuous data as median (IQR). p_1: Fisher's exact test, p_2: Kruskal Wallis H test (Post-Hoc: Adj. Dunn's test; a,b: indicates significant difference between groups marked with different letters, P<0.05). *Not included in analysis due to insufficient observations.*

Table 3: Distribution of presenting complaints

Presenting Complaint	TR n(%)	CTAS n(%)
Headache	10 (3.45)	15 (4.55)
Dizziness	6 (2.07)	7 (2.12)
Muscle pain	40 (13.79)	57 (17.27)
ENT problems	35 (12.07)	28 (8.48)
Palpitations	3 (1.03)	1 (0.30)
Dyspnea	18 (6.21)	18 (5.45)
Chest pain	8 (2.76)	10 (3.03)
Eye problems	18 (6.21)	26 (7.88)
Abdominal pain	27 (9.31)	16 (4.85)
Extremity problems	22 (7.59)	33 (10.00)
Falls	12 (4.14)	17 (5.15)
Skin problems	18 (6.21)	8 (2.42)
Bites and stings	15 (5.17)	19 (5.76)
Vomiting-Diarrhea	8 (2.76)	7 (2.12)
Syncope	6 (2.07)	7 (2.12)
Abscess and local infection	4 (1.38)	4 (1.21)
Urinary problems	16 (5.52)	23 (6.97)
Pregnancy and gynecological problems	5 (1.72)	1 (0.30)
Psychiatric problems	2 (0.69)	1 (0.30)
Diabetes	0 (0.00)	1 (0.30)
GI bleeding	0 (0.00)	1 (0.30)
Neurological complaints	2 (0.69)	1 (0.30)
Seizure	0 (0.00)	1 (0.30)
Foreign body aspiration	0 (0.00)	1 (0.30)
Test request	14 (4.83)	21 (6.36)
Admission request	0 (0.00)	2 (0.61)

ENT problems: Ear, nose and throat problems, GI bleeding: Gastrointestinal bleeding

Table 4: TR and Expert consensus comparison

TR Category	Expert Consensus			
	Emergent	Urgent	Standard	Total
Emergent	4	0	0	4
Urgent	0	35	0	35
Standard	0	80	171	251
Total	**4**	**115**	**171**	**290**

Weighted Kappa = 0.375; P <0.001

Table 5: CTAS and Expert consensus comparison

CTAS Category	Expert Consensus					
	Resuscitation	Emergent	Urgent	Less Urgent	Non-Urgent	Total
Resuscitation	3	0	0	0	0	3
Emergent	0	10	0	0	0	10
Urgent	0	0	57	0	0	57
Less Urgent	0	0	0	66	0	66
Non-Urgent	0	0	0	34	160	194
Total	**3**	**10**	**57**	**100**	**160**	**330**

Weighted Kappa = 0.835; P <0.001

Table 6: Distribution of Laboratory Tests, Radiological Examinations and Consultation

Requirements According to TR and CTAS Triage Categories

	Laboratory examination		Radiological examination		Consultation	
	No	Yes	No	Yes	No	Yes
TR						
Emergent	1 (25.00)	3 (75.00)[a]	1 (25.00)	3 (75.00)	1 (25.00)	3 (75.00)[a]
Urgent	30 (88.24)	4 (11.76)[b]	23 (67.65)	11 (32.35)	30 (88.24)	4 (11.76)[b]
Standard	135 (54.00)	115 (46.00)[a]	151 (60.40)	99 (39.60)	182 (72.80)	68 (27.20)[a,b]
Total	166 (57.64)	122 (42.36)	175 (60.76)	113 (39.24)	213 (73.96)	75 (26.04)
X^2; *P*	17.52; <0.001		2.69; 0.245		8.18; 0.013	
CTAS						
Resuscitation	1 (33.33)	2 (66.67)	1 (33.33)	2 (66.67)[a,b]	0 (0.00)	3 (100.00)[a]
Emergent	4 (40.00)	6 (60.00)	4 (40.00)	6 (60.00)[a,b]	5 (50.00)	5 (50.00)[a,b]
Urgent	30 (52.63)	27 (47.37)	12 (21.05)	45 (78.95)[a]	29 (50.88)	28 (49.12)[a]
Less Urgent	37 (56.06)	29 (43.94)	42 (63.64)	24 (36.36)[b]	49 (74.24)	17 (25.76)[a,b]
Non-Urgent	107 (55.15)	87 (44.85)	122 (62.89)	72 (37.11)[b]	157 (80.93)	37 (19.07)[b]
Total	179 (54.24)	151 (45.76)	181 (54.85)	149 (45.15)	240 (72.73)	90 (27.27)
X^2; *P*	1.67; 0.817		35.59; <0.001		28.43; <0.001	

Discussion

The CTAS system demonstrated significantly higher agreement with expert opinion (κ=0.84) compared to the TR system (κ=0.38), indicating the superior reliability of the five-level triage system. This finding is consistent with previous multicenter studies reporting consistently high reliability rates for CTAS across various healthcare settings [4,18].

The significant difference in lower triage rates between TR (28%) and CTAS (12%) represents a critical advantage in terms of patient safety. Sub-triage poses significant risks by causing delays in appropriate care for patients with high urgency. The lower sub-triage rate observed with CTAS is consistent with previous studies emphasizing the importance of minimizing this risk for optimal patient outcomes [11,19].

Resource utilization analysis demonstrates that CTAS promotes more rational allocation of healthcare resources. The significantly higher rate of radiological examinations in T3 patients compared to lower urgency levels indicates the system's ability to align resource intensity with patient urgency appropriately. This contrasts with the TR system, where resource allocation models are less aligned with patient needs.

The more balanced patient distribution observed in CTAS compared to the patient distribution concentrated in the green category in TR indicates that the five-level system provides more detailed patient categorization. This enhanced level of detail enables better resource planning and workflow management in emergency departments [20].

While the TR system offers advantages in terms of simplicity and rapid implementation, these advantages should be evaluated in comparison with proven patient safety concerns and inadequate resource utilization models. The learning curve and implementation time required for CTAS can be overcome with structured training programs, as demonstrated in previous implementation studies [7].

Limitations

This study was conducted at a single center and only during daytime hours, which may limit its generalizability to different implementation settings and patient populations. The design, which varied the days, minimized bias but may have introduced temporal differences in patient presentations. Future multicenter studies including night shift evaluations will strengthen the evidence base for triage system comparisons.

Conclusion

This study demonstrates that the CTAS system significantly outperformed the TR system in several critical areas of emergency department operations. Superior alignment with expert opinions, significantly lower triage error rates, and more rational resource utilization models supported the implementation of CTAS in emergency departments aiming to optimize patient safety and operational efficiency.

The findings indicated that while the TR system offered simplicity in practice, the advantages demonstrated by CTAS in patient safety and resource management justify the additional training and implementation requirements. Healthcare institutions considering triage system optimization should prioritize patient safety outcomes and resource efficiency over ease of implementation.

Future research should focus on validating these findings in a multicenter setting and exploring implementation strategies that can facilitate the successful adoption of CTAS while minimizing transition challenges.

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