Anatolian Journal of Emergency Medicine 2019;2(3); 1-7

ORIGINAL ARTICLE / ÖZGÜN ARAŞTIRMA MAKALESİ

Dokuz Eylul Triage System: A five category triage algorithm, reliability and validity study

Dokuz Eylül Triyaj Sistemi: Beş kategorili triyaj algoritmi, geçerlilik ve güvenilirlik çalışması

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ÖZET

Giriş: Triyaj sistemleri, acil servis bekleme alanlarında hastalığın ciddiyetini tespit etmede faydalı araçlardır. Hastalık ve hasta profili açısından benzerlik eksikliği nedeniyle, her triyaj sistemi başka bir ülkede etkili olmayabilir. Dokuz Eylül Triyaj Sistemi beş seviyeli bir triyaj sistemi olarak geliştirildi ve bu yazıda Dokuz Eylül Triyaj Sistemi üçüncü seviye bir acil serviste kullanılarak geçerliliği ve güvenilirliği değerlendirildi.

Yöntem: Bu çalışma üçüncü basamak acil serviste yapıldı. Çalışmaya bir ay içerisinde acil servise başvuran ve sistematik örnekleme yöntemi ile seçilen hastalar alındı. Hastane yatışı, acil serviste kalış süresi, 48 saat sonundaki mortalite, kaynak kullanımları geçerlilik için değerlendirildi ve kör eşleştirilmiş triyaj kategorileri güvenilirlik için ağırlıklı Kappa analizi ile karşılaştırıldı.

Bulgular: Beş yüz altmış yedi hasta çalışmaya alındı; 30'u dışlandı. Kalan 537 hastanın %55'i kadındı ve ortanca yaş 46 idi. Hastalardan yedisinin triyaj seviyesi-1 (%1.3), 142'sinin triyaj seviyesi-2 (%26.4), 167'sinin triyaj seviyesi-3 (%31.1), 166'sının triyaj seviyesi-4 (%30.9) ve 55'inin triyaj seviyesi-5 (%10,3) bulundu. Triyaj kategorileri için ağırlıklı Kappa, 0.825 olarak bulundu. Triyaj kategorisi kaynak kullanımı, hastanede yatış oranları, ortalama kalış süresi ve 48 saat mortalite, triyaj seviyesi ile kuvvetli olarak ilişkili bulundu. Aşırı triyaj oranı %15,5, triyaj altı oranı %3,7 ve triyaj sisteminin triyaj kategorisi 1 ve 2'deki hastalar için duyarlılığı %99,3 ve özgüllüğü %96 olarak hesaplandı.

Sonuçlar: Dokuz Eylül Triyaj Sistemi, bir üçüncü derece acil serviste klinik uygulamaya yerleştirilecek kadar güvenilir ve geçerli beş kategorili bir triyaj algoritmasıdır. Dokuz Eylül Triyaj Sisteminin, canlandırma ve acil bakım ihtiyacı olan hastaları güvenle tespit edip eleyebildiği bu çalışma ile rapor edilmiştir.

Anahtar kelimeler: Triyaj, geçerlilik, güvenilirlik

ABSTRACT

Introduction: Triage systems are useful tools to detecting severity of illness in the emergency department's waiting areas. Because of the lack of similarity in terms of disease and the patient profile each triage system may not be effective in another country. Dokuz Eylul Triage System was developed as a five-level triage system and this paper evaluates validity and reliability of Dokuz Eylul Triage System to use in a tertiary Turkish emergency department.

Methods: This study was performed in a tertiary emergency department. Patients with any symptoms who were admitted to the emergency department in one-month period and selected by systematic sampling method were included into the study. Hospital admission, length of stay in the emergency department, 48h mortality, resource uses were assessed for validity and blinded paired triage assignments were compared with weighted kappa analysis for reliability.

Results: Five-hundred-sixty-seven patients were enrolled; 30 were excluded. The resulting of 537 patients was 55% female and had a median age of 46 years. Seven of them were triage level-1 (1.3%), 142 of them were level-2 (26.4%), 167 of them were level-3 (31.1%), 166 of them were level-4 (30.9%) and 55 of them were level-5 (10.3%). Weighted kappa for triage assignment was found as 0.825. Resource use, hospitalization rates, mean length of stay and 48h mortality were found as strongly associated with triage level. Over-triage rate was 15.5%, under-triage rate was 3.7% and the sensitivity and specificity of the triage system were calculated 99.3% and 96%.

Conclusions: Dokuz Eylul Triage System is a reliable and validated five-category triage algorithm for Turkey to be implanted into clinical practice of a tertiary emergency department. We report that Dokuz Eylul Triage System could be able to detect and sieve the patients safely who need resuscitation and emergent care.

Keywords: Triage, reliability, validity

Received: August, 19, 2019 Accepted: August, 29, 2019

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Atıf için/Cited as: Dikme Ö, Atilla R, Oray NÇ, Saraçoğlu G, Girfin MC, Akyol PY. Dokuz Eylul Triage System: A five category triage algorithm, reliability and validity study.Anatolian J Emerg Med 2019;2(3); 1-7

Introduction

Triage is the initial clinical sorting of patients according to the acuteness of their problems. Ideally all emergency departments (EDs) should be provided as soon as the evaluation and treatment for the admitted patients but many of them cannot supply this because of the overcrowding, lack of resources or limited beds. Therefore, triage systems usage in the EDs has become more frequent and many triage systems have been developed. An appropriate routine ED triage allows to decisions about who should receive treatment priority and who can wait for treatment.[1, 2] The velocity of assessment and the accuracy of the decision are often critical for patient safety. Three (3L), four (4L), and five (5L) level triage systems have been successfully implemented worldwide in the countries of North America, Europe, the Middle East and Australasia since the development of Emergency Medicine as a specialty about 50 years ago. Majority of the triage system studies report that 5L triage systems yield a higher level of reliability and validity than 3L triage systems. Whereas 5L triage systems already prevails in the worldwide, the 3L triage system has been commonly used in Turkey as suggested in the statement published in 2009 by the Ministry of Health of Turkish Government. If we would have a look at worldwide 5L triage systems, Canadian Triage and Acuity Scale (CTAS) and Manchester Triage System (MTS), both of are symptom-based scales.[3-5] CTAS is developed from National Triage System (NTS) which was the first form of Australasian Triage System (ATS). As differ from the others MTS has a flowchart and has appropriate triage categories for identified each disease. Emergency Severity Index (ESI) is the most commonly used and widely studied in the United States, which is classified the patients by estimated resource needs and utilization. There are various studies about accuracy, reliability and validity of acute patient triage in ATS-NTS, MTS, CTAS and ESI 5L triage systems.[3-11]

As in many low to middle income countries there is no a common standard 5L triage system in Turkey. Although several triage systems have been previously developed and validated, each system is in currently wide use only in its own community. Overcrowding (1.000 or more patients/day) is a big problem for the EDs and triage areas. When the evaluation time is long in the triage area violent actions may be occur by patients who do not tolerate waits in overcrowded EDs. Because of this an emergency triage system is needed that can be applied quickly, does not require any education or experience and is determined based on the priority for care according to the chief complaints, pre-diagnosis or symptoms of the patients. To address this need, a complaint based 5L Dokuz Eylul Triage System (DETS) has been developed in a tertiary university hospital ED for detach the medical situation's urgency and minimize the medical risks on patients while waiting. This study evaluates validity and reliability for DETS for use in a tertiary Turkish ED.

Methods

This prospective, cross-sectional, descriptive, clinical study which approved by the local ethics committee was performed in an academic ED with 60000 visits annually. This study was carried out with 537 patients who were selected with systematic sampling method between 01/06/2009 and 01/07/2009.

In the first stage, paramedics who were working at the triage area received a training program. They are the first medical contact for the ED attending patients. For the standardization of training program, training was delivered by a single instructor who is owner of the study. Training was lasted 48 hours and 11 paramedics were attended. The theoretical part of training was included definition and categories of DETS and the practical part was included scenarios and real time practice. The paramedics were standardized with pre-post tests and these were statistically analyzed. Pre-posttest means were found respectively 6.5/10 and 8/10 and the training success was found that statistically significant (p=0.0078, Wilcoxon Test).

In the study time, totally 5671 patients admitted to the ED with any complaint. The study population was selected with the systematic sampling method which was already used for French Emergency Nurses Classification in Hospital scale (FRENCH) validity study.[12] Study sample size was planned to cover at least 10% of the universe. Used by systematic sampling method, the first patient was selected randomly, and then every tenth patient from there included the study. Patients who not agreed to participate in the study were excluded at the end of the study without change in patient selection order. Sixteen patients were not agreed to participate study and 14 patients were under than 18 age. Therefore 30 patients were excluded from the study and the study population consisted of 537 patients.

In the second stage, patients arriving at the ED were evaluated by paramedics according to the DETS (Figure1). DETS was firstly described at 2009. Most commonly used and widely studied triage systems were examined and DETS was developed to include a tertiary ED patients' characteristics and needs. It is a physiology and symptom-based scale and has a flowchart for application convenience.

The patients were rated between DETS1 (highest acuity) and DETS5 (lowest acuity). All of the categories were defined clearly. DETS1 defined as patients need for resuscitation who were unresponsive, no pulse or no breath. Having any life-threatening conditions for its life or any part of body function with had any one of the red flags were addressed to DETS2. DETS3 defined as patients who may be cause serious problems and need emergency interventions situations with

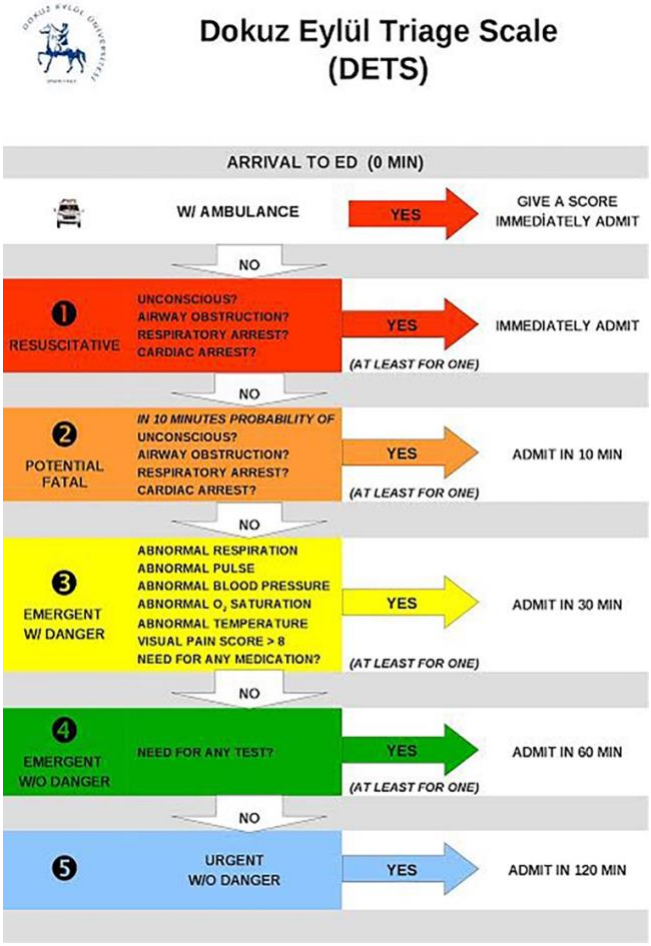

Figure 1. Dokuz Eylul Triage System

had not any red flags. If possibility of providing assistance or interventions can be done in hours depending on the patient's age, distress, deterioration or undesirable situations, patients was defined as DETS4. And finally, DETS5 defined as an acute but not emergent cases or chronic diseases. Patients were received into the ED with suggested their categorical waiting time, respectively, DETS1 without ever waited, DETS2 at most 10 min, DETS3 at most 30 min, DETS4 at most 60 min and DETS5 at most 120 min. In the wait process if patient was described any additional symptoms, the categorization was started again and he/she took a new triage category.

Initial assessment was consisted of five steps and evaluated at the triage area at first 10 minutes: (1) general condition which was evaluated by subjectively as good, medium or poor; (2) chief complaint; (3) vital signs (systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse rate (PR), respiratory rate (RR), Temperature (T), peripheral oxygen saturation (PO_2S)); (4) short neurological examination (AVPU=Alert, respond Verbal stimuli, respond Painful stimuli, Unresponsive); and (5) numeric pain rating scale (NPRS). NPRS was used only alert patients and scored 1-3 painless, 4-7 mild pain, 8-10 severe pain. Also the red flags of DETS were defined as SBP >180 or <90 mmHg, DBP >100 or < 60 mmHg, PR <60 or >120/min, RR <10 or >20/min, T <36 or >38 ^{o}C, PO_2S < 90%, general condition was poor, neurological examination was not alert and NPRS was scored 8-10.

In the third stage of the study, all of the patients' records were retrospectively re-categorized by a physician who was blinded the paramedics' scores. To assessment reliability of DETS, paramedic's versus physician's scores were compared with inter-rater agreement and weighted kappa value was calculated. When paramedics' results were found higher than physician's results this was accepted as over-triage and when found lower than it this was accepted as under-triage. Also, paramedics' specificity and sensitivity for identifying patients in the group with a potential risk of death –DETS1 and DETS2- were calculated together.

Hospital admission, mean length of stay (LOS) in the ED, 48h mortality and need for resource usage rates were assessed for validity of the DETS. The hospital admission was assessed in two subgroups respectively ward and intensive care unit (ICU). The mean LOS in the ED was calculated as hour. For the 48h mortality, discharged patients were phoned and asked the viability. Inpatient subjects' data were collected from hospital database. The need for resource usage was considered positive by requirement of laboratory, radiography or both.

All calculations were analyzed with MedCalc® v10.1.6 statistical software. Descriptive analysis was performed in all patients. Continuous data were presented as means with standard deviation (SD) and categorical data as rates. The independent t-test was used to compare continuous variables between two subgroups. The p values for comparisons of categorical variables were generated by the chi-square test. To determine the eligibility of two practitioners inter-rater agreement test was performed and weighted kappa values were calculated which were graded using the Landis and Koch classification system as follows: up to 0.20 slight agreement; 0.21-0.40 fair agreement; 0.41-0.60 moderate agreement; 0.61-0.80 substantial agreement and 0.81-1.00 almost perfect agreement.[13] Relative risk for 48h mortality was expressed in terms of odds ratios. The accuracy of the paramedic DETS result was assessed by calculating the sensitivity, specificity, over and under-triage ratings. Over- and under-triage were interpreted using an accepted range for average under-triage of not more than 5% and an associated average over-triage rate of 30%. All of the statistical analysis was done with 95% confidence intervals (CI) and p value <0.05 was considered statistically significant.

Results

Of the patients in the study, 242 were men, 295 were women and the average age was 46.4±19.5 years old. The study patients' characteristics were displayed in Table1 and the outcome measures within the triage categories were

		Total	DETS1	DETS2	DETS3	DETS4	DETS5
		n=537	n=7	n=142	n=167	n=166	n=55
Gender	M	242	3	81	67	66	25
	F	295	4	61	100	100	30
Age*		46.4±19.5	47.4±24.2	59.6±18.1	43.3±17.9	41.3±18.1	36.9±14.3
Min/Max		18/91	20/79	18/91	18/84	18/88	18/71
SBP*		131.7±23.8	114.9±52.3	136.2±28.9	131.3±22.9	130.1±18.5	127.9±18.5
Min/Max		0/241	0/155	73/241	87/220	90/180	90/202
DBP*		80.7±14.9	71.0±33.7	85.1±17.5	80.0±15.0	78.8±11.2	78.4±11.9
Min/Max		0/145	0/97	50/145	50/145	45/114	51/112
PR*		87.1±17.3	89.3±44.0	90.3±21.8	87.3±14.6	85.9±13.8	81.5±14.0
Min/Max		0/167	0/127	53/167	57/123	59/121	60/116
RR*		17.5±4.6	16.9±10.4	20.7±6.3	16.7±2.7	16.2±2.9	16.1±2.8
Min/Max		0/50	0/32	12/50	12/28	12/25	12/20
PO_2S*		97.4±5.7	74.6±37.2	95.4±5.3	98.5±1.2	98.6±1.2	98.6±1.3
Min/Max		0/100	0/100	68/100	95/100	95/100	95/100
T*		36.4±0.6	35.9±0.4	36.4±0.7	36.5±0.7	36.4±0.5	36.2±0.4
Min/Max		35.0/39.8	35.0/36.3	36.0/39.8	35.8/39.1	35.1/39.3	35.4/38.1
General Condition	Good Medium	487-90.7%	1-0.2%	103-19.2%	162-30.2%	166-30.9%	55-10.2%
	Poor	39-7.3%	1-0.2%	33-0.6%	5-0.9%	0	0
		11-2.0%	5-0.9%	6-1.1%	0	0	0
AVPU	A	522-97.2%	0	134-25.0%	167-31.1%	166-30.9%	55-10.2%
	V	9-1.7%	2-0.4%	7-1.3%	0	0	0
	P	1-0.2%	1-0.2%	0	0	0	0
	U	5-0.9%	0	0	0	0	0
NPRS	1-3	341-65.3%	-	95-18.2%	85-16.3%	115-22%	46-8.8%
	4-7	112-21.5%	-	20-3.8%	34-6.5%	49-9.4%	9-1.7%
	8-10	69-13.2%	-	19-3.6%	48-9.2%	2-0.4%	0

*Mean±SD, DETS: Dokuz Eylul Triage System, SBP: systolic blood pressure (mmHg), DBP: diastolic blood pressure (mmHg), PR: pulse rate(/min), RR: respiratory rate (/min), T: Temperature (^oC), PO_2S: peripheral oxygen saturation (%), SD: standard deviation, NPRS: Numeric Pain Rating Scale.

Table1. Initial information of patients in triage.

displayed in Table2. When compared in terms of time severe groups -DETS1 and DETS2 together- had fewer mean waiting time in the triage area (95% CI, 4.110-5.035), fewer mean seen time by a physician (95% CI, 5.487-8.748) and higher mean LOS in the ED (95% CI, 7.167-10.915). When the hospital admission rate and the need for resource usage rate were evaluated one by one versus the DETS severity, in the severe groups both of them (n=149) were found higher than the non-severe groups (p<0.001, Chi-Square Tests). Also, ICU admissions were found that in only severe categories. Mortality on 48h rate was found as 1.9%. Four of them were died in the ED and 6 of them were died in the ICU. When evaluated in terms of 48h mortality, in severe groups DETS was able to predict in hospital mortality (OR: 58.5, 95% CI: 3.4-1004.7, p= 0.005).

According to admission complaint; the most commons were related to musculoskeletal (n=100), gastrointestinal (n=95) and cardiovascular (n=66) systems respectively (Table3). The cardiovascular and pulmonary system problems were significantly higher in patients with DETS1 and DETS2. When evaluated in terms of general condition status, 487 of them (90.7%) were found as good. NPRS evaluation was calculated

on 522 patients. According to AVPU scale 15 patients were respectively found that 9 in verbal, 1 in painful, 5 in unresponsive and they were excluded for the evaluation of NPRS. The study patients' initial assessment characteristics were displayed in Table1.

When compared in terms of inter-rater agreement, weighted kappa value was calculated as 0.825 (Table4). This rate was graded using the Landis and Koch classification system and it was placed in almost perfect agreement. It means there was 82.5% consistency between the paramedics and the physicians. Over-triage rate was calculated as 15.5% (n=83) and under-triage rate was calculated as 3.7% (n=20). When evaluated in terms of severe groups' determination by the paramedics, sensitivity and specificity were found that respectively 99.3% and 96% (Table5).

Discussion

DETS is a 5L triage category that provides to prioritize patient care needs and examine patient medical care situations. In this prospective study, we investigated the reliability and validity of the DETS in a tertiary ED and this study showed that DETS is a valid and reliable tool for detecting severe patients in the triage area. For the assessment of reliability,

	LOS, Mean±SD	Resource usage, n (%)	Hospitalization, n (%)	48h mortality, n (%)	Total, n
DETS1	11.0±18.2	6 (85.7%)	7 (100%)	3 (42.9%)	7
DETS2	11.0±17.9	130 (91.5%)	63 (44.4%)	7 (4.9%)	142
DETS3	3.0±5.2	82 (49.1%)	27 (16.2%)	0 (0%)	167
DETS4	1.2±1.6	59 (35.5%)	7 (4.2%)	0 (0%)	166
DETS5	0.7±0.5	8 (14.5%)	1 (1.8%)	0 (0%)	55
Totally	4.4±10.7	285 (53.1%)	105 (19.6%)	10.1	537

DETS: Dokuz Eylul Triage System, LOS: Length of stay in the ED (hours), SD: standard deviation.

Table2. The outcome measures within the triage categories.

Because of this, the validity of DETS was evaluated with mean LOS in the ED, hospital admission rate, need for resource usage rate and 48h mortality rate. Average mean LOS in the ED was found to be 4.4±0.5 hours.the inter-rater agreement test was used and kappa value was found perfect agreement (κ=0.825).

Similarly, with our study, in 1999 the first CTAS reliability assessment study was showed that kappa value for the physician was 0.83 and for the nurses was 0.84.[14] In our study, the paramedics' over-triage rate was calculated as 15.5% and under-triage rate was calculated as 3.7%. They were placed in accepted range for trauma patient's triage which was for average under-triage as 5-10% and for average over-triage rate as 30-50% by the ACSCOT. A triage study from Turkey with using ATS reported that the agreement between the triage decisions made by paramedics and emergency physicians was 45% across all cases (κ=0.45), 16.7% of triage decisions were under-triage and 22.9% of them were over-triage. As a result, they concluded that real-time ATS triage in a Turkish ED was a lower level of agreement than paper-based ATS triage scenarios in other countries. (24) In another triage study from Turkey, ESI was compared with a local university 5L triage system and they suggested using a complaint-based 5L triage system for overcrowded EDs. (25)

Admission complaint	DETS					Total
	DETS1	DETS2	DETS3	DETS4	DETS5	
Musculoskeletal system	0	13	17	51	19	100 (18.6%)
Gastrointestinal system	0	11	59	24	1	95 (17.7%)
Cardiovascular system	2	50	7	5	2	66 (12.3%)
Nervous system	1	21	20	21	2	65 (12.1%)
Genitourinary system	0	8	23	16	2	49 (9.1%)
Respiratory system	3	28	7	2	0	40 (7.4%)
Head and neck related	0	3	10	15	11	39 (7.3%)
Infectious diseases	0	3	9	11	6	29 (5.4%)
Dermatological diseases	0	1	5	12	6	24 (4.5%)
Psychiatric disorders	0	1	3	3	6	13 (2.4%)
Obstetrics and gynecology	0	1	4	3	0	8 (1.5%)
Others	1	2	2	2	1	8 (1.5%)

Table3. Distribution of admission complaints of patients according to the systems.

The validity of a triage system can be described as correctly classified by each patient according to medical treatment needs. There is no standardized system for evaluating the validity of the triage systems. In the literature, validity studies usually have been used parameters such as mortality

rates, hospitalization, ICU admission, LOS in the ED, resource or consultation requirements and ED charges.[10-20] When the mean LOS in the ED was evaluated the longest time was observed in DETS1 and DETS2. We think that the reason of this is the DETS1 and DETS2 patients were requiring more hospital admissions. Also, to be a second cause because of our hospital occupancy rates admission requiring patients may observe in the ED for a while. Similarly, ESI ver.2 validity research showed that category-1 and 2 patients had longest time in the ED.[10] Also ESI ver.1 validity research reported similarly mean LOS hours.[20]

		Paramedics Triage					
		DETS 1	DETS2	DETS3	DETS4	DETS5	Total
Physician Triage	DETS1	7#	0	0	0	0	7 (1.3%)
	DETS2	0	126#	1	0	0	127 (23.6%)
	DETS3	0	16	107#	8	0	131 (24.4%)
	DETS4	0	0	59	150#	11	220 (41.0%)
	DETS5	0	0	0	8	44#	52 (9.7%)
	Total	7 (1.3%	142 (26.4%	167 (31.1%	166 (30.9%	55 (10.2%	537

*İnter-rater agreement, weighted-kappa=0.825 #Denotes perfect agreement

DETS: Dokuz Eylul Triage System

Table4. Reliability of DETS Triage Ratings*

Analogously CTAS validity research reported that longest LOS in category-1 as 176 minutes.[18] Hospital admission rate and the need for resource usage rate were found high in DETS1 and DETS2. Similarly for the validity of ESI, MTS and CTAS researches showed that when the triage categorization was increased to severity hospital admission rates was found high.[11, 17, 18, 20] Also these researches and additionally FRENCH validity research showed that when the triage categorization was increased to severity need for resource rates was found high.[12, 15, 17, 18] 48h mortality rate was found in only DETS1 and 2 patients and the paramedics' determination sensitivity and specificity were found that respectively 99.3% and 96%. In a validation study for ESI ver.2 reported that 60 days mortality was higher in category-1 patients.[10] Also in ESI ver.3 reported similarly.[11] And this is an expected condition. Severe patient has red flags in initial assessment such as abnormal vital signs, dangerous symptoms or poor general condition which all of these are mortality indicators.

When triage systems which were developed for other countries are used in different countries, they may not be effective. We see examples of these conditions in the literature. Therefore many countries have tried to develop a unique triage system like France, South Africa.[12, 21, 22]

Paramedics' Triage	DETS 1 & DETS 2	95% CI
Sensitivity	99.3%	95.9–99.9%
Specificity	96%	93.6–97.1%
(+)LR	25	15.5–40.4
(-)LR	0.01	0–0.005
PPV	89.3%	83.2–93.7%
NPV	99.7%	98.6–100%

(+) LR: Positive likelihood ratio, (-) LR: Negative likelihood ratio, PPV: Positive predictive value, NPV: Negative predictive value, CI: Confidence Interval, DETS: Dokuz Eylul Triage System

Table5. Paramedics' Triage sensitivity and specificity to detect the patients in DETS1 and DETS2.

As well as the differences in patient and disease profiles, Jobé et al. argued that development of the triage system in their own language which was more effective and useful.[21] Also some authors are opposite of this idea. For example, Worster et al.'s study which was compared ESI and CTAS in North America showed that no difference between to detecting accuracy.[23] The South African Triage Scale (SATS) is a physiology and symptom-based scale that is widely used in low to middle income settings throughout Africa and the Middle East. It is probably a much better comparison country to Turkey than any of the nations whose triage scales are mentioned before.

Limitations

This study has several limitations. The most important limitation was the lowest number of ED admission. In the study time the average daily admission was found as 190. Because of this we believe that a more crowded ED should be evaluating to the DETS reliability and validity. Also because of this low admission numbers, there wasn't any reassessed patient in the triage area and we didn't measure to DETS's reassessment situations. And finally, we didn't know the value of the DETS in the pediatric age group.

Conclusion

DETS is a 5L triage algorithm which is reliable and validated to be implanted into clinical practice of a tertiary university hospital ED. We report that DETS could be able to detect and sieve the patients safely who need resuscitation and emergent care in our study.

Conflict of Interest: All authors have no conflict of interest to disclose.

Funding: None

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