Title: Comparing Emergency Severity Index (ESI) and Manchester Triage System (MTS) Triage Systems in Trauma Patients: Correlations with the Injury Severity Score (ISS) and Clinical Outcomes

Authors: Amirhossein Mirafzal[1], Arman Khajoue[1], Mehdi Torabi[1,*], Sara Azizi Shoul[1], Ahmad Naghibzadeh-Tahami[2]

1. *Department of Emergency Medicine, Kerman University of Medical Sciences, Kerman, Iran.*
2. *Modeling in Health Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran.*

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Abstract

Background: This study compares the Emergency Severity Index (ESI) and Manchester Triage System (MTS), focusing on their correlation with the Injury Severity Score (ISS) and outcomes in trauma patients.

Materials and Methods: In this cross-sectional observational study with prospective patient inclusion and dual real-time triage, 400 trauma patients were triaged using the ESI by five experienced hospital triage nurses as part of routine care and using the MTS by five separate skilled emergency nurses trained specifically for this study in the emergency department (ED) of an Academic Hospital, a level II trauma center from March 1, 2024, to June 1, 2024. Because each patient received both triage classifications, paired statistical methods were used for all direct comparisons between the two systems. Triage levels from the two systems were compared with each other and with the ISS. Secondary outcomes included hospitalization, discharge within 24 hours, mortality, and length of stay (LOS).

Results: The MTS and ESI showed moderate correlation ($\rho = 0.352$, 95% CI: 0.262–0.435, $p < 0.001$). Increasing triage severity levels in both systems were moderately associated with higher ISS and longer LOS ($p < 0.001$). At non-emergency levels, both systems had similar rates of patients discharged within the first 24 hours (MTS: 80.7%; ESI: 80.6%). However, the proportion of patients classified as emergent was lower with MTS (Orange/Red: 5.5%,95% CI: 3.6–8.2) compared with ESI (Levels 1/2: 8.5%, 95% CI: 6.1–11.7%) (p=0.008), with emergent patients in both systems showing high hospitalization rates (MTS: 78.95%–100%; ESI: 53.33%–75%). The mortality rate was identical (0.5%) for both triage systems. Both triage systems showed similar moderate-to-large correlations with ISS and LOS. Over-triage rates were higher with ESI (6.5%, 95% CI: 4.5–9.3%) than MTS (3.0%, 95% CI: 1.7–5.2%) (p=0.01), while under-triage rates were similar (ESI 14.1%, 95% CI: 9.7–20.1% vs. MTS 15.0%, 95% CI: 10.4–21.2%; p=0.62).

Conclusion: The ESI and MTS exhibited similar performance and a positive correlation with outcomes for trauma patients. Increased severity in both systems was significantly associated with higher ISS and longer LOS. Both systems showed comparable proportions of non-emergency patients discharged, with the ESI classifying more patients as emergent. ESI exhibited a tendency to over-triage relative to MTS, while under-triage rates remained comparable. MTS may offer higher specificity, although this is confounded by study design.

Keywords: Emergency Severity Index, Injury Severity Score, Manchester Triage System, Trauma, Emergency Department, Triage Systems

Introduction

Triage is a critical process in emergency departments (EDs) for prioritizing patients based on the urgency of their need for medical resources. Triage systems are implemented globally to optimize resource allocation and time management, ensuring timely and prioritized patient care. However, the accuracy of these systems varies across different patient conditions, such as trauma [1-3].

The Emergency Severity Index (ESI) is a five-level triage algorithm designed to assess patients' need for life-saving interventions (acuity-based) and resource utilization. It begins by evaluating a patient's airway, breathing, and circulation to determine if immediate intervention is required [4]. Patients are then categorized into five levels based on these assessments. Level 1 includes patients requiring immediate life-saving treatment, such as those with recent or sudden changes in consciousness, those responding only to painful stimuli, or those unresponsive to pain. Level 2 is assigned to patients in high-risk situations (e.g., confused, lethargic, or disoriented), those with severe pain, or those with unstable vital signs. High urgency (Levels 1–2) is driven either by immediately life-threatening conditions or by the expectation that the patient will consume ≥2 critical resources. Levels 3 to 5 are determined by the number of hospital resources required. Despite some limitations, the ESI remains a simple and effective tool for nurses to assess patient triage levels and is the primary triage system used in the United States [5-7].

The Manchester Triage System (MTS) is one of the most widely used triage systems in Europe. The MTS is purely discriminator-based and symptom-oriented: urgency is determined solely by the presence and priority of clinical discriminators in pre-defined flowcharts, without explicit consideration of anticipated resource use. It employs 52 flowcharts based on patient complaints, incorporating additional signs and symptoms known as "discriminators" to identify worsening conditions [8]. These discriminators play a key role in trauma cases by prioritizing symptom severity over resource needs alone. These discriminators are prioritized from most to least severe. The urgency of care is determined by maximum waiting times: Red (immediate attention), Orange (up to 10 minutes), Yellow (up to 1 hour), Green (up to 2 hours), and Blue (up to 4 hours). Triage nurses are trained to use these flowcharts to accurately categorize patients based on their clinical condition. The MTS is considered a valid tool for the initial assessment of emergency patients, particularly those in critical condition upon arrival [8-10], with recent enhancements incorporating digital discriminators for improved accuracy [11].

Prioritizing trauma patients based on injury severity is crucial, as timely and high-quality treatment directly impacts patient outcomes. For trauma research, comparison of triage systems requires an objective reference standard for injury burden [12]. The Injury Severity Score (ISS) is a well-established clinical tool for assessing trauma severity, correlating with mortality, morbidity, and hospital length of stay (LOS). The ISS is calculated using the Abbreviated Injury Scale (AIS), which classifies injuries by severity across different body regions. To compute the ISS, the highest AIS severity scores from the three most severely injured body regions are squared and summed, with an ISS greater than 15 indicating multiple trauma. Therefore, ISS provides an appropriate benchmark for examining whether triage classifications accurately reflect underlying injury severity and predict relevant clinical outcomes [13, 14].

The ESI system has been refined through studies focusing on the urgency and severity of symptoms rather than waiting times. However, its sensitivity and specificity are limited, particularly in crowded EDs where nurses must rapidly identify critical patients [7]. In our region, ESI is the standard triage system used in EDs. We hypothesized that both systems would correlate with ISS, while MTS would classify fewer patients as emergent than ESI. Given its limitations, particularly in trauma centers, this study aims to compare the performance of the ESI and MTS in a trauma referral center (defined as a level II facility specializing in trauma care with high-volume admissions), with a focus on the Injury Severity Score (ISS) and trauma patient outcomes. This investigation innovates by using a paired real-time triage in trauma patients, with blinded ISS as an anatomical reference, to quantify over/under-triage and inform resource allocation in high-volume centers [16]. Outcomes evaluated include discharge within the first 24 hours, admission to a ward or intensive care unit (ICU), mortality, and length of stay (LOS), based on the ESI and MTS triage systems.

Materials and Methods

Study design and setting

This cross-sectional observational study with prospective consecutive patient inclusion and dual real-time triage was conducted in the ED of Shahid Bahonar Academic Hospital, a level II trauma center with over 70,000 admissions annually, in Kerman, Southeastern Iran, from March 1, 2024, to June 1, 2024. This study employed a non-randomized, fixed-order design in which ESI triage was consistently performed before MTS, using separate nurse groups. While this approach preserved routine clinical workflow, it introduces potential systematic bias, including order effects and inter-operator variability. Specifically, experienced ESI nurses may have had a lower threshold for assigning high urgency compared with newly trained MTS nurses. These limitations were partially mitigated through standardized training and sensitivity analyses; however, residual confounding remains and all comparative findings should be interpreted cautiously.

Participants

The study included trauma patients aged 18 years or older admitted to the ED during the study period. Exclusion criteria were age under 18 years, transfer to another facility within the first 24 hours, referral from an external trauma center, non-traumatic conditions, death immediately upon ED admission, and incomplete medical records.

Patients were consecutively enrolled during the study period and received both ESI (by routine triage nurses) and MTS (by dedicated study nurses) triage in real time. All other outcome variables were subsequently extracted from the hospital's electronic medical records. Eligible trauma patients were triaged by five trained nurses using the ESI across three shifts daily. To minimize errors, researchers provided refresher training on ESI triage to these nurses prior to the study. As ESI triage is standard in the hospital, all eligible ED patients meeting inclusion criteria were enrolled. The ESI is a five-level triage system that categorizes patients based on disease severity and resource needs, assessing for life-threatening conditions, serious manifestations, and unstable vital signs. For the MTS, five skilled emergency nurses without prior triage experience were selected to avoid bias. These nurses underwent 8 hours of combined theoretical and practical

training on MTS triage, achieving kappa=0.79, comparable to established benchmarks [17]. During training, nurses evaluated MTS triage accuracy using case examples.

Before the study began, a preliminary triage of 40 patients was conducted by these trained nurses, demonstrating good agreement in triage level assignment (kappa coefficient = 0.79, $p < 0.001$). Subsequently, patients were triaged first with the ESI by the original triage nurses (per hospital routine) and then with the MTS by the newly trained nurses. This separate nurse group design was chosen due to institutional policies mandating ESI as standard, to prevent interference with routine care; however, it may introduce comparability bias, which was mitigated through standardized training. To address potential bias from different nurse groups, we conducted a sensitivity analysis excluding cases with discrepant vital signs (n=40, results unchanged). Future studies should randomize triage order and use cross-trained nurses to minimize this bias.

The Injury Severity Score (ISS) served as the anatomical reference standard for injury severity. After patient discharge or final disposition, a medical doctor—who had completed formal training in the Abbreviated Injury Scale (AIS-2005 with 2008 update) and who was completely blinded to both ESI and MTS triage categories—assigned AIS codes to all injuries using definitive radiological reports, operative findings, and discharge diagnoses documented in the electronic medical record. The three highest AIS scores from different body regions were squared and summed to obtain the ISS. Inter-rater reliability was verified on a randomly selected 10% subset of cases by an independent senior trauma clinician (also blinded to triage categories), yielding a kappa coefficient of 0.85.

Study size

Sample size was calculated for a paired design aiming to detect a clinically meaningful difference of ≥4% in the proportion of patients classified as emergent/high-urgency (ESI 1–2 vs. MTS Red/Orange), assuming a baseline emergent rate of ~7% and a paired discordance of ~6%. With $\alpha=0.05$ and power=90%, and using the formula for McNemar's test for paired proportions, a minimum of 376 patients was required. We enrolled 400 patients to account for potential missing data.

Data sources

A checklist was designed to collect demographics (age, sex), triage levels (ESI and MTS), ISS, and outcomes (discharge, admission, mortality, LOS), extracted from electronic medical records by a medical doctor. ISS was calculated post-discharge using definitive diagnoses and was performed blinded to the triage assignments of both systems. Data extraction was validated through double-entry for 20% of records to ensure accuracy. Data are available via the institutional repository or upon reasonable request from the corresponding author.

Outcomes

The primary outcome was the comparison of ESI and MTS in the trauma referral center based on the ISS. Secondary outcomes included discharge within 24 hours, admission (wards or ICUs), mortality, and LOS.

The threshold of ISS >15 was selected as it is widely accepted in trauma research as the definition of major trauma, associated with significantly increased morbidity, mortality, and resource utilization. This cutoff is commonly used in validation studies of triage systems and provides a clinically meaningful benchmark for evaluating under- and over-triage. Over-triage (low ISS but high urgency) and under-triage (high ISS >15 but low urgency) rates were also explored as exploratory metrics using ISS as the gold standard for major trauma. Over-triage was defined as assignment to a high-urgency triage category despite the absence of major trauma severity (ISS ≤15). For this study, high urgency was defined as ESI Levels 1–2 or MTS Red/Orange categories. Under-triage was defined as assignment to a lower-urgency triage category in patients with clinically significant trauma severity (ISS >15). Lower urgency was defined as ESI Levels 3–5 or MTS Yellow/Green/Blue categories.

Ethical considerations

The study was approved by the Ethics Committee of Kerman University of Medical Sciences, Kerman, Iran [IR.KMU.AH.REC.1403.031]. All patients or their relatives provided written informed consent.

Statistical Analysis

Data were analyzed using SPSS software, version 23.0 (SPSS Inc., Chicago, IL, USA). Normality was assessed using the Shapiro-Wilk test. Normally distributed data were presented as mean ± standard deviation (SD), while non-normally distributed data were reported as median and interquartile range (IQR). Qualitative variables were expressed as frequencies (percentages). Spearman's rank correlation coefficient (ρ) was used to assess the strength and direction of associations between ranked variables (e.g., triage levels vs. ISS or LOS). Multivariable ordinal logistic regression was performed with ISS category as the dependent variable and triage level (1–5, reversed so higher number = higher urgency) as the main predictor, adjusting for age, sex, and mechanism of injury (blunt vs. penetrating). Because every patient was triaged with both ESI and MTS, the data are paired. Direct comparisons of triage category distributions and binary outcomes (e.g., emergent vs. non-emergent, hospitalization vs. discharge) between the two systems were performed using McNemar's test. Comparisons across the full five-level scales used the Stuart-Maxwell test for marginal homogeneity. Over-triage and under-triage rates (using ISS >15 as the reference for major trauma) were compared using McNemar's test. A two-sided p-value less than 0.05 was considered statistically significant.

Results

A total of 845 patients were assessed over a three-month period, with 400 patients ultimately included in the study (Figure 1).

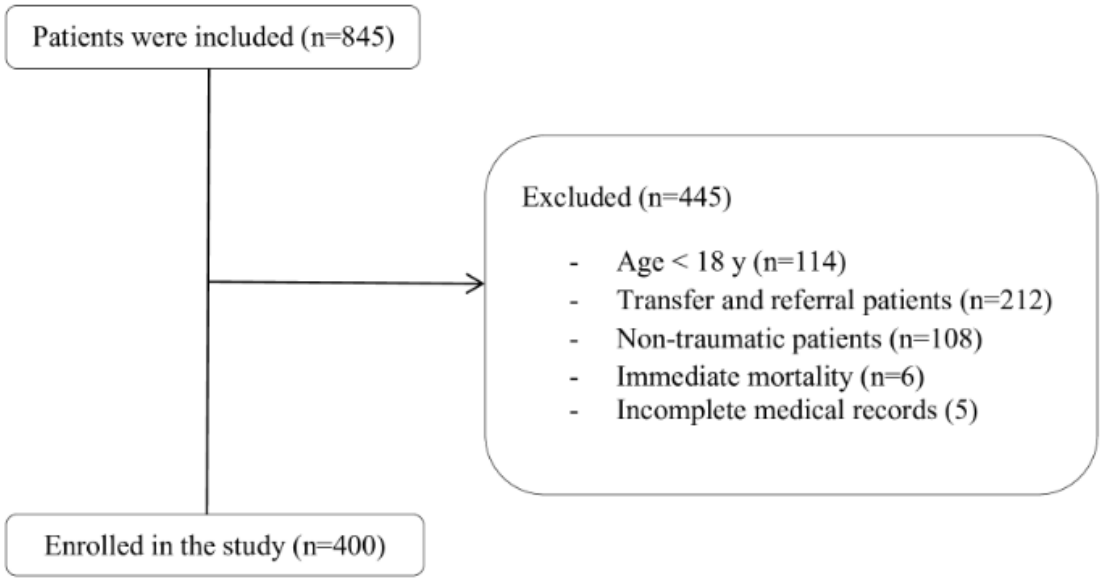

Fig. 1 Flow chart showing enrollment of patients

The mean age of participants was 31.67 ± 14.88 years, and the majority were male (56.75%). The median Injury Severity Score (ISS) was 14 (interquartile range [IQR], 9–20.75). Of the included patients, 77.5% were discharged, 20.25% were admitted to wards, 1.75% were admitted to ICUs, and 0.5% died. According to the MTS, most patients were assigned to the Green (43.25%) or Yellow (28.25%) levels. Based on the ESI, patients were primarily classified as Level 3 (40.5%) or Level 4 (38%). Additionally, 5.5% of patients were assigned to the orange or red levels (MTS), while 8.5% were assigned to Levels 1 or 2 (ESI) (Table 1).

Table1. Distribution of demographic variables, outcomes, ISS[1], ESI[2], and MTS[3] in traumatic patients

Variables	N(%), mean ±SD, median [IQR]
Age(Year)	31.67±14.88
Sex	
Men	227 (56.75%)
Women	173 (43.25%)
Outcomes	
Discharge in the first 24 hours	310 (77.5%)
Admission to the ward	81 (20.25%)
Admission to the ICU	7 (1.75%)
Mortality	2 (0.5%)
LOS[4] (Days)	1 [1-1.75]
ISS	14 [9-20.75]
ESI	
Level 5	52 (13%)
Level 4	152 (38%)
Level 3	162 (40.5%)
Level 2	30 (7.5%)
Level 1	4 (1%)
MTS	
Blue	92 (23%)
Green	173 (43.25%)
Yellow	113 (28.25%)
Orange	19 (4.75%)
Red	3 (0.75%)

Injury Severity score[1], Emergency Severity Index[2], Manchester Triage Scale[3], Length of stay[4]

When the population was dichotomized by the median ISS (≤14 vs. >14), both systems showed significantly higher urgency levels in the ISS >14 group (Wilcoxon rank-sum $p < 0.001$ for both). Similar findings were observed using the conventional major-trauma cutoff ISS >15. The relationship between the triage systems showed a significant moderate positive correlation (Spearman's $\rho = 0.352$, 95% CI: 0.262–0.435, $p < 0.001$). Both systems showed moderate-to-large negative correlations with ISS (MTS: $\rho = -0.540$, 95% CI: -0.606 to -0.468, $p < 0.001$; ESI: $\rho = -0.576$, 95% CI: -0.641 to -0.505, $p < 0.001$) and moderate with LOS ($\rho = -0.431$ and -0.442, respectively, both $p < 0.001$) (Table 2).

Table2. Correlation of ESI[1], MTS[2] with each other and ISS[3]

	MTS	ESI	ISS
ESI	0.352	1	-0.576
(Spearman correlation coefficient)			
p-value	<0.001	-	<0.001
MTS	1	0.352	-0.540
(Spearman correlation coefficient)			
p-value	-	<0.001	<0.001

Emergency Severity Index[1], Manchester Triage Scale[2], Injury Severity score[3]

Similarly, the relationship between LOS and both MTS ($\rho = -0.431$, 95% CI: -0.502 to -0.354, $p < 0.001$) and ESI ($\rho = -0.442$, 95% CI: -0.512 to -0.366, $p < 0.001$) was significant, moderate, and negative, indicating that as triage severity increased (from MTS Blue or ESI Level 5 to MTS Red or ESI Level 1), LOS increased.

The frequency distribution of outcomes (discharge within 24 hours, admission to wards or ICUs, and mortality) was evaluated based on MTS and ESI. Of patients at MTS Blue level, 92.39%, and at ESI Level 5, 94.23%, were discharged within 24 hours. At MTS Green level, 82.08%, and at ESI Level 4, 90.13%, were discharged within 24 hours. At MTS Yellow level, 69.03%, and at ESI Level 3, 67.28%, were discharged within 24 hours. Overall, 80.7% of patients at non-emergency levels (Blue, Green, and Yellow) based on MTS and 80.6% at non-emergency levels (Levels 3, 4, and 5) based on ESI were discharged within 24 hours. The proportion of patients classified as emergent was lower for MTS (Orange or Red: 5.5% of total sample, with 78.95%–100% hospitalized) than for ESI (Levels 1 or 2: 8.5% of total sample, with 53.33%–75% hospitalized). All deceased patients (n = 2) were classified as MTS Red or ESI Level 1 (Table 3).

Table3. Frequency distribution of discharge, admission, and mortality in traumatic patients based on ESI[1] and MTS[2]

Variables	Hospital Discharge n(%)	Ward Admission n(%)	ICU Admission n(%)	Mortality n(%)
ESI				
Level 5	49(94.23%)	3(5.77%)	0(0%)	0(0%)
Level 4	137(90.13%)	15(9.87%)	0(0%)	0(0%)
Level 3	109(67.28%)	53(32.72%)	0(0%)	0(0%)
Level 2	14(46.67%)	10(33.33%)	6(20%)	0(0%)
Level 1	0(0%)	1(25%)	1(25%)	2(50%)
MTS				
Blue	85(92.39%)	7(7.61%)	0(0%)	0(0%)
Green	142(82.08%)	31(17.92%)	0(0%)	0(0%)
Yellow	78(69.03%)	35(30.97%)	0(0%)	0(0%)
Orange	4(21.05%)	8(42.11%)	7(36.84%)	0(0%)
Red	0(0%)	0(0%)	1(33.33%)	2(66.67%)

Emergency Severity Index[1], Manchester Triage Scale[2]

Exploratory analysis showed over-triage rates of approximately 10% for ESI vs. 5% for MTS, and under-triage rates of 15% for both; these suggest ESI's potential over-classification due to resource focus.

The proportion of patients classified as emergent/high-urgency was significantly lower with MTS (Red + Orange: 22/400, 5.5%, 95% CI: 3.6–8.2) than with ESI (Level 1 + 2: 34/400, 8.5%, 95% CI: 6.1–11.7) (McNemar's test, p=0.008). Among the 34 patients classified as ESI 1–2, 16 (47%) were downgraded to MTS Yellow/Green/Blue, whereas only 4 of the 22 MTS Red/Orange patients were upgraded by ESI (exact McNemar odds ratio not computable due to zero cell, but p=0.008 confirms significant difference). Hospitalization rate among patients classified as emergent was 90.9% (20/22) for MTS vs. 64.7% (22/34) for ESI (McNemar's test on paired discordant pairs, p=0.03), indicating higher specificity of MTS emergent categories. The proportion of patients classified as emergent/high-urgency was significantly lower with MTS (Red + Orange: 22/400, 5.5%) than with ESI (Level 1 + 2: 34/400, 8.5%) (McNemar's test, p=0.008). Among the 34 patients classified as ESI 1–2, 16 (47%) were downgraded to MTS Yellow/Green/Blue, whereas only 4 of the 22 MTS Red/Orange patients were upgraded by ESI (exact McNemar odds ratio not computable due to zero cell, but p=0.008 confirms significant difference). Hospitalization rate among patients classified as emergent was 90.9% (20/22) for MTS vs. 64.7% (22/34) for ESI (McNemar's test on paired discordant pairs, p=0.03). Although this finding suggests higher specificity for MTS, it should be interpreted cautiously because the paired discordant comparison is based on a relatively small number of discordant cases, which may inflate the statistical significance.

Over-triage rates were higher for ESI (26/400, 6.5%, 95% CI: 4.5–9.3%) compared with MTS (12/400, 3.0%, 95% CI: 1.7–5.2%) (p=0.01). However, this difference should be interpreted with caution, as the use of separate nurse groups and fixed triage order may have influenced urgency assignment, potentially predisposing ESI nurses toward higher acuity classification. Under-triage

rates were similar (ESI 14.1% vs. MTS 15.0%, p=0.62), but the relatively wide confidence intervals indicate limited precision, and the study may be underpowered to detect clinically meaningful differences (Table 4).

Table 4. Paired comparison of ESI[1] and MTS[2] performance in 400 trauma patients

Outcome	ESI	MTS	p-value
Emergent Classification	34 (8.5%)	22 (5.5%)	0.008
Hospitalization	22/34 (64.7%)	20/22 (90.9%)	0.03
Over-triage (ISS[3] ≤15 but high-urgency)	26 (6.5%)	12 (3.0%)	0.01
Under-triage (ISS >15 but low-urgency)	24/170 (14.1%)	25/167 (15.0%)	0.62

Emergency Severity Index[1], Manchester Triage Scale[2], Injury Severity score[3]

Discussion

This study should be interpreted in light of important methodological limitations. The non-randomized design, fixed triage order, and use of separate nurse groups introduce systematic bias that limits causal interpretation of differences between ESI and MTS. In particular, differences in clinical experience and training between nurse groups may have influenced triage decisions, especially for high-urgency classifications. Within these constraints, our findings suggest a trend toward lower emergent classification rates and potentially higher specificity with MTS compared with ESI. However, this apparent difference may reflect study design factors rather than intrinsic superiority of either triage system. Therefore, these results should be viewed as hypothesis-generating rather than definitive. This study demonstrated that MTS and ESI exhibited comparable performance and a significant moderate positive correlation (Spearman's $\rho = 0.352$, $p < 0.001$) in prioritizing trauma patients. The escalation in triage severity levels in both systems was moderately correlated with increased ISS and prolonged LOS in trauma patients. At non-emergency levels, the MTS and ESI showed similar percentages of patients discharged within the first 24 hours (80.7% vs. 80.6%). However, the ESI classified more patients as emergent (8.5% for Levels 1 and 2, with 53.33%–75% hospitalized) compared to the MTS (5.5% for Orange and Red categories, with 78.95%–100% hospitalized), with high hospitalization rates observed in emergent categories for both systems. This difference may arise from ESI's integration of resource utilization, which could lead to over-classification in trauma scenarios where anticipated needs inflate urgency, whereas MTS's flowchart-based discriminators provide higher specificity. Mortality rates were identical in both systems, with all deaths occurring at the highest urgency levels (MTS Red and ESI Level 1). A strength of the study is that the reference standard (ISS) was determined after patient disposition using complete diagnostic information and by an assessor who was fully blinded to the ESI and MTS triage categories, thereby reducing the risk of review bias in the validation of the two triage systems. When analyzed using appropriate paired statistical methods, the MTS classified significantly fewer patients as emergent/high-urgency than the ESI (5.5% vs. 8.5%, McNemar p=0.008), with higher hospitalization rates among those classified as emergent by MTS (90.9% vs. 64.7%, p=0.03). This suggests a trend toward higher specificity of the MTS

in this trauma population, consistent with its reliance on symptom-based discriminators rather than anticipated resource use. Amid evolving triage challenges, including ED crowding [15-17], this study's findings on MTS's specificity resonate with 2025 validations emphasizing symptom discriminators over resource predictions [18,19].

Accurate triage is critical for timely provision of appropriate care and for reducing complications and injury exacerbation, whereas incorrect triage can worsen outcomes and increase complications [20,21]. Developing a universally effective triage system is challenging but essential [22]. A meta-analysis by Zachariasse et al. found that the ESI and MTS have moderate to good validity for identifying patients with high and low urgency, with both systems showing reasonable performance in emergency departments [23]. The present study confirms a significant correlation between the ESI and MTS and between these systems and the ISS in trauma patients. Similarly, Storm-Versloot et al. evaluated 900 patients and found comparable validity among the ESI, MTS, and ISS, with no single system demonstrating superiority [24]. These findings align with these, showing a significant moderate correlation between the ESI and MTS ($\rho = 0.352$, $p < 0.001$) and moderate-to-large negative correlations with the ISS (MTS: $\rho = -0.540$, $p < 0.001$; ESI: $\rho = -0.576$, $p < 0.001$), indicating that higher triage urgency corresponds to greater injury severity in trauma patients. Critically, while correlations are similar, the lower emergent classification in MTS suggests better specificity in resource-limited settings, aligning with recent multicenter studies showing ESI's higher under-triage risk in low-urgency levels [19].

Regarding LOS and mortality, Zakeri et al. (2022) studied 447 and 468 trauma patients triaged with the ESI and MTS, respectively, and found similar hospitalization rates across triage levels. They reported a significant relationship between triage level/category and mean LOS in the ED, except for the highest urgency levels (MTS Red and ESI Level 1). This may reflect their use of mean LOS comparisons, whereas our study used Spearman correlations across all levels [25]. In contrast, this study found a significant negative correlation between both triage systems and LOS (MTS: $\rho = -0.431$, 95% CI: -0.502 to -0.354, $p < 0.001$; ESI: $\rho = -0.442$, 95% CI: -0.512 to -0.366, $p < 0.001$), indicating that higher urgency levels (MTS Red or ESI Level 1) were associated with longer LOS, consistent with increased ISS. Additionally, higher urgency levels were associated with greater resource use and LOS across triage systems [23].

Van der Wulp et al. reviewed 37,974 patients triaged with the ESI and 34,258 with the MTS, finding that hospitalization probability decreased with lower urgency levels and was higher for ESI-triaged patients than for MTS-triaged patients. ESI patients required more emergent interventions, and mortality was low in both systems, primarily occurring at the highest urgency levels [26]. Sookmee et al. analyzed 71,247 non-traumatic patients and found that LOS decreased across ESI levels, with the highest in-hospital mortality at ESI Level 1 [27]. The present study showed that non-emergency levels (MTS Blue, Green, and Yellow; ESI Levels 3, 4, and 5) had comparable discharge rates within 24 hours (80.7% for MTS vs. 80.6% for ESI). Emergent-level patients had lower discharge rates and higher hospitalization, with the MTS classifying fewer such patients overall (5.5%, 78.95%–100% hospitalized) than the ESI (8.5%, 53.33%–75% hospitalized). Mortality occurred only at the highest urgency levels (MTS Red and ESI Level 1) in two cases.

Emergency departments worldwide use various triage systems to assess patient severity and prioritize treatment. Christ et al. reported that five-level triage systems, such as the ESI, are more valid and reliable than three-level systems, with the ESI showing good to very good reliability (κ = 0.7–0.95) compared to moderate reliability for the MTS (κ = 0.3–0.6) [28]. Storm-Versloot et al. found higher interobserver agreement for the MTS (unweighted κ = 0.76) than for the ESI (κ = 0.46), with weighted κ values of 0.82 and 0.73, respectively [24]. Cairós-Ventura et al. reported high sensitivity (89%, 95% CI: 85–93%) and specificity (97%, 95% CI: 94–99%) for the ESI, with a very good inter-rater agreement (κ = 0.88, 95% CI: 0.82–0.98) [29]. De Souza et al. found moderate to substantial reliability for the MTS (κ = 0.55–0.72 externally; 0.57–0.78 internally) [16]. This study aligns with these findings, showing a significant moderate correlation between the ESI and MTS and moderate-to-large negative correlations with the ISS.

Limitations

This study could not assess the ESI and MTS in separate patient groups due to institutional policies, limiting direct comparisons with mortality rates. Potential bias from using different nurse groups (experienced for ESI, novice for MTS) may affect comparability, though mitigated by training and preliminary kappa (0.79). This non-randomized assignment and fixed order (ESI first, MTS second) create systematic bias that very likely favors the ESI and makes it impossible to definitively attribute observed performance differences (e.g., higher emergent classification rate with ESI) solely to inherent characteristics of the two algorithms. Although we attempted to mitigate this through standardized training and sensitivity analyses, residual confounding from operator expertise and potential "anchoring" of the second triage on the first remains a critical threat to the internal validity of direct head-to-head comparisons. The low mortality (0.5%) and ICU admission (1.75%) rates limit power for rare outcomes; larger multi-center studies are recommended. Although we adjusted for age, sex, and mechanism of injury in multivariable models, residual confounding by unmeasured variables (e.g., comorbidities, time of day, ED crowding) cannot be excluded. The young age, relatively low injury severity (median ISS 14), and extremely low rates of mortality and ICU admission represent important limitations that reduce the power to detect differences in prognostic performance for life-threatening outcomes. The modest event rate (7.75%) constrains definitive conclusions about discriminative ability in severely injured patients. Other patient groups (e.g., non-trauma patients) and additional emergency care units should be investigated to enhance the generalizability of these findings. The single-center design limits broader applicability. Future studies should employ randomized cross-trained nurses, expand to multi-centers, and include diverse populations (e.g., pediatrics, geriatrics) to address these issues.

Conclusion

The ESI and MTS demonstrated similar overall performance and correlations with ISS and clinical outcomes in trauma patients. Although MTS classified fewer patients as emergent and showed a lower over-triage rate, these findings may reflect differences in nurse assignment, experience, and study design rather than true differences in system performance. Therefore, no definitive conclusions regarding superiority can be drawn. Future studies using randomized designs with cross-trained nurses are required before making clinical recommendations.

Abbreviations

AIS: Abbreviated Injury Scale

ED: Emergency Department

ESI: Emergency Severity Index

ISS: Injury Severity Score

IQR: Interquartile Range

LOS: Length of Stay

MTS: Manchester Triage System

SD: Standard Deviation

Declarations Ethics approval and consent to participate: The Ethics Committee of the … University of Medical Sciences approved this study (IR.KMU.AH.REC.1403.031).

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