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EFFECTIVENESS OF PREHOSPITAL TRAUMA TRIAGE TOOLS IN IMPROVING PATIENT OUTCOMES: A SYSTEMATIC REVIEW

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Abstract

Background: Effective prehospital triage is critical to ensure that severely injured patients are rapidly identified and transported to appropriate trauma centres. We synthesised evidence on the predictive performance of prehospital trauma triage tools and their relationship with key outcomes. Methods: Using a predefined corpus of 9 original studies, we conducted a narrative systematic review according to PRISMA principles. Eligible original studies evaluated triage tools (GAP, MGAP, NEWS2, TRISS, RTS, Shock Index, mREMS) using patient-important outcomes; review/guideline articles contextualised under-/over-triage, geriatric triage, and tool heterogeneity. Results: Across diverse settings, several tools showed strong discrimination for mortality and early resuscitative needs. AUROCs were high for MGAP (0.971 and 0.949 in different cohorts), GAP (0.949–0.935), mREMS (0.967), and TRISS (0.934). NEWS2 performed best for very early mortality but less well for longer horizons. Shock Index (prehospital and ΔSI) predicted transfusion, ICU admission, operative need, and short-term mortality signals in selected cohorts. However, under-triage remained common—particularly in older adults—despite guideline updates, and thresholds varied widely between systems. Conclusions: Prehospital triage tools can accurately stratify risk and inform destination decisions, but performance is tool- and population-dependent. Persistent under-triage among older adults and heterogeneity in thresholds support adopting age-attuned criteria, continuous monitoring for NEWS2-based approaches, and rigorous system-level evaluation against under-/over-triage targets.

Keywords: Prehospital Triage; Trauma; GAP; MGAP; TRISS; NEWS2; Shock Index; mREMS; Under-Triage; Over-Triage.

INTRODUCTION

Trauma is a leading cause of death and disability worldwide, with time-critical pathways that depend on accurate identification of severely injured patients before hospital arrival (Lupton et al. 2023). Field triage tools aim to minimise under-triage (seriously injured patients transported to non-trauma hospitals) while keeping over-triage within acceptable limits to avoid overwhelming high-level centres. Despite decades of iterative improvements, recent evaluations indicate substantial variation in performance across regions, age groups and implementations (Lupton et al. 2023).

Older adults are vulnerable to mistriage. Physiological responses to injury can be blunted, common medications (beta-blockers, anticoagulants) alter typical vital-sign cues, and serious injury often follows seemingly 'low-energy' mechanisms such as ground-level falls. A systematic review of elderly-specific criteria found improved sensitivity compared with generic adult tools, but specificity remained modest and real-world outcome data were limited (Boulton et al. 2021). Current best-practice statements likewise support lower activation thresholds and tailored criteria for older adults (Egodage et al. 2024).

External validation studies comparing prehospital prognostic models suggest that tools frequently discriminate mortality better than they identify major trauma (ISS>15), underscoring a mismatch between statistical performance and practical case-finding for major injury (Sewalt et al. 2020). Separately, early warning approaches such as NEWS2 demonstrate strong accuracy for very early mortality, but attenuation for in-hospital and 30-day endpoints, supporting a role as a continuous monitoring aid rather than a single time-point screen (Wei et al. 2023).

Guideline processes have continued to update criteria and targets. The 2021 National Expert Panel on Field Triage re-emphasised minimising under-triage (≤5%) while accepting higher over-triage (≤35%), adding or revising criteria using likelihood ratios and AUROCs to strengthen predictive utility (Newgard et al. 2021). Against this backdrop, we synthesised original studies of prehospital triage tools and contextual reviews to describe current performance, gaps, and opportunities for improvement.

METHODS

We performed a systematic narrative review aligned with PRISMA principles. The evidence base comprised a predefined set of 17 papers supplied by the authors: nine original studies evaluating prehospital triage tools and eight systematic reviews/guidelines providing broader context. We included studies that: (i) assessed one or more prehospital triage scores or protocols (GAP, MGAP, TRISS, RTS, NEWS2, Shock Index, modified Rapid Emergency Medicine Score [mREMS]); and (ii) reported patient-important outcomes (mortality, severe injury [ISS>15], need for resuscitative

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interventions, transfusion, operative care, ICU admission). Review/guideline articles were included if they synthesised triage accuracy, under-/over-triage, geriatric triage, or tool operationalisation.

Screening and selection: Two reviewers (single-team process) inspected titles and full texts of the provided corpus. All 17 met inclusion. No additional database searches were undertaken beyond the supplied set. Data extraction captured design, setting, population, triage tool(s), primary outcome(s), and discrimination metrics, plus calibration or threshold-based accuracy (sensitivity/specificity) when reported. For guideline/review articles, we extracted target under-/over-triage levels, identified gaps (older-adult mistriage), and harmonisation recommendations.

Risk of bias: For original diagnostic-type studies, we qualitatively considered applicability and reporting completeness (cohort assembly, outcome ascertainment, handling of missing data). Outcomes and synthesis: The primary objective was discrimination for mortality, severe injury (ISS>15), and early resuscitative needs. Secondary objectives included system performance (under-/over-triage) and population-specific considerations (older adults). We present a descriptive summary of original studies (Table 1) and their reported performance metrics (Table 2), and integrate findings with contemporary reviews/guidelines in the Discussion.

RESULTS

Nine original studies with diverse EMS systems, populations, and modelling approaches were included. Broadly, physiologic scores (GAP/MGAP/RTS/mREMS), composite models (TRISS), early-warning systems (NEWS2), and vital-sign ratios (Shock Index, including prehospital and ΔSI) were evaluated. One large quality-improvement study assessed a digital triage decision-support intervention and its association with mistriage.

Study characteristics are summarised in Table 1. Performance metrics are detailed in Table 2. Key findings by tool are narrated below. GAP, MGAP, and RTS: In an Upper Egypt cohort, MGAP, GAP, and RTS all showed good discrimination for mortality (AUROC 0.879, 0.890, and 0.881, respectively), with negative predictive values exceeding 95%; MGAP demonstrated the highest sensitivity (94%) (Mohammed et al. 2022). In a Thai high-risk cohort aimed at predicting resuscitative interventions within 24 h, MGAP and GAP again performed strongly (AUROC 0.971 and 0.949, respectively), and a GAP threshold <19 optimised ruling-out patients not needing resuscitative interventions (specificity 94.4%, NPV 94.1%) (Jenpanitpong et al. 2025).

Expanded comparisons: A large prehospital dataset from Iran comparing R-GAP, GAP, and New Trauma Score (NTS) found AUROCs of 0.904, 0.935, and 0.884, respectively, with high odds ratios for mortality prediction across models (Kenarangi et al. 2024). In a national US NTDB validation, mREMS achieved AUROC 0.967 for in-hospital mortality, outperforming RTS (0.959), MGAP (0.964), and markedly exceeding Shock Index (0.670) (Miller et al. 2017).

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TRISS and NEWS2: Using prehospital datasets linked to hospital outcomes, TRISS had the highest AUROC for mortality (0.934), followed by NEWS2 (0.879), while simpler components (GCS 0.815; RTS 0.812; ISS 0.774) trailed; TRISS had the highest sensitivity and RTS the highest specificity (Yousefi et al. 2024). A meta-analysis focused on NEWS2 reported excellent pooled accuracy for very early (≤2-day) mortality but weaker performance for in-hospital and 30-day mortality, suggesting utility as a monitoring-based triage adjunct rather than a sole gatekeeper (Wei et al. 2023).

Shock Index: In a multicentre rural US study, initial EMS Shock Index predicted blood transfusion and ICU admission; increases in ΔSI were associated with operative intervention. Mortality signals increased with each 0.1 increment in EMS SI, with statistical significance varying by subgroup; overall, SI and ΔSI were highlighted as important prehospital markers in rural prolonged-transport settings (Bardes et al. 2023). Complementing this, a very large registry analysis in patients with normal ED SI showed that abnormal prehospital SI (low ≤0.4 or high ≥0.9) was independently associated with higher 24-h mortality (adjusted odds ratio 1.63 for both low and high groups) (Yamada et al. 2023).

Digital decision support and mistriage: A population-based quality-improvement intervention in three Dutch trauma regions showed that implementing a triage-app–based intervention reduced under-triage from 31.8% to 26.8% without increasing over-triage (≈21% both periods), corresponding to an adjusted risk ratio for under-triage of 0.85 (95% CI 0.76–0.95) (Lokerman et al. 2023).

Older adults: In a French multicentre prehospital cohort graded A/B/C at scene by physician-led teams, overall, in-hospital mortality was 7.1%. Triage sensitivity for mortality was consistently lower among adults ≥65 years than younger patients for both high-acuity (Grade A: 50.5% vs 74.6%) and intermediate categories (Grade B: 89.5% vs 97.2%), with modestly lower specificity as well (Benhamed et al. 2023).

Table 1: Characteristics of included original studies (x1–x9).

Study (Year)	Setting/Population	Design	Tool(s)	Primary Outcomes	Key Findings
Bardes et al. (2023)	4 US Level-1 centres; rural catchments; adults with blunt chest/abdominal trauma, >60 min from scene	Retrospective multicentre registry	Prehospital Shock Index (SI), ΔSI	Transfusion, ICU admission, operative intervention, mortality	EMS SI predicted transfusion and ICU; ΔSI predicted operative need; mortality odds rose per 0.1 SI (signal varied by subgroup).
Lokerman et al. (2023)	3 Dutch trauma regions; all adult EMS transports (n=80,738)	Prospective quality-improvement (before/after implementation)	Triage app intervention (decision support)	Under-triage, over-triage	Under-triage fell 31.8%→26.8%; over-triage unchanged (~21%); adjusted RR under-triage 0.85 (0.76–0.95).

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Mohammed et al. (2022)	Upper Egypt; adult ED trauma; Jan–Aug 2016	Retrospective single-centre cohort	MGAP, GAP, RTS	In-hospital mortality	AUROC MGAP 0.879; GAP 0.890; RTS 0.881; NPV >95%; MGAP sensitivity 94%.
Benhamed et al. (2023)	France; physician-led EMS; adults; 2011–2021 (n=8,888)	Retrospective multicentre cohort	3-tier prehospital severity grading (A/B/C)	In-hospital mortality; severe trauma	Mortality 7.1%. Sensitivity for mortality lower in ≥65y vs younger: Grade A 50.5% vs 74.6%; Grade B 89.5% vs 97.2%.
Kenarangi et al. (2024)	Iran; prehospital EMS traffic injuries (n=47,971)	Analytical cross-sectional	R-GAP, GAP, New Trauma Score (NTS)	In-hospital mortality	AUROC: R-GAP 0.904; GAP 0.935; NTS 0.884.
Jenpanitpong et al. (2025)	Thailand; high-risk/life-threatening prehospital trauma (n=440)	Retrospective cohort	T-RTS, GAP, MGAP, NEWS-2, SI, rSIG	Resuscitative interventions (24 h)	AUROC: T-RTS 0.969; MGAP 0.971; GAP 0.949; NEWS-2 0.929; GAP<19: Sp 94.4%, NPV 94.1%.
Miller et al. (2017)	US National Trauma Databank (n≈429,711 for validation subset)	Model modification + external validation	mREMS vs RTS, MGAP, SI, ISS	In-hospital mortality	mREMS AUROC 0.967; RTS 0.959; MGAP 0.964; SI 0.670.
Yousefi et al. (2024)	Iran; largest trauma centre prehospital dataset (n=4,191)	Retrospective diagnostic study	NEWS2, TRISS, RTS, GCS, ISS	In-hospital mortality	TRISS AUROC 0.934; NEWS2 0.879; GCS 0.815; RTS 0.812; TRISS sensitivity 77.5%; RTS specificity 94.0%.
Yamada et al. (2023)	Japan; national registry; trauma ≥16y with normal ED SI (n=89,495)	Retrospective cohort	Prehospital SI (low ≤0.4; high ≥0.9 vs normal)	24-h mortality	Adjusted OR 24-h mortality: 1.63 (low SI) and 1.62 (high SI) vs normal prehospital SI.

Table 2: Reported performance metrics of prehospital triage tools in the included original studies.

Study	Tool(s)	Primary metric(s)	Key values	Notes
Mohammed et al. (2022)	MGAP, GAP, RTS	AUROC; Sens; NPV	MGAP 0.879; GAP 0.890; RTS 0.881; Sens (MGAP) 94%; NPV >95%	Upper Egypt single-centre ED cohort.
Jenpanitpong et al. (2025)	T-RTS, MGAP, GAP, NEWS-2	AUROC; threshold accuracy	T-RTS 0.969; MGAP 0.971; GAP 0.949; NEWS-2 0.929; GAP<19 Sp 94.4%, NPV 94.1%	High-risk/life-threatening EMS.
Kenarangi et al. (2024)	R-GAP, GAP, NTS	AUROC	R-GAP 0.904; GAP 0.935; NTS 0.884	Large prehospital traffic-injury cohort.

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Miller et al. (2017)	mREMS vs RTS, MGAP, SI	AUROC	mREMS 0.967; RTS 0.959; MGAP 0.964; SI 0.670	National validation on NTDB.
Yousefi et al. (2024)	TRISS, NEWS2, RTS, GCS, ISS	AUROC; Sens; Spec	TRISS 0.934 (Sens 77.5%); NEWS2 0.879; RTS 0.812 (Spec 94.0%)	Prehospital dataset linked to outcomes.
Bardes et al. (2023)	SI, ΔSI	Associations	EMS SI → transfusion & ICU; ΔSI → operative need; mortality odds ↑ per 0.1 SI	Rural prolonged-transport systems.
Yamada et al. (2023)	Prehospital SI	Adjusted OR (24-h mortality)	Low SI: OR 1.63; High SI: OR 1.62 (vs normal prehospital SI)	All had normal ED SI, highlighting prehospital risk signal.
Lokerman et al. (2023)	Triage app intervention	Under-/Over-triage	Under-triage 31.8%→26.8%; Over-triage ≈21% (unchanged); adj RR under-triage 0.85	Population-based QI.
Benhamed et al. (2023)	3-tier grading (A/B/C)	Sensitivity/Specificity (mortality)	Older adults: A 50.5% sens; B 89.5% sens; Spec 69.4% (older) vs 74.6% (younger)	Physician-led EMS.

DISCUSSION

This synthesis shows that several triage tools, particularly MGAP/GAP, mREMS, TRISS and NEWS2, offer strong discrimination for mortality and, in some cohorts, for early resuscitative interventions.

Three persistent themes emerge across studies and contemporary reviews: (1) under-triage remains above targets in many systems, especially for older adults; (2) discrimination for mortality does not necessarily equate to optimal identification of major trauma (ISS>15); and (3) operational heterogeneity in thresholds and criteria contributes to variable real-world performance (Lupton et al. 2023; Sewalt et al. 2020; Donnelly et al. 2025).

Under-/over-triage: The 2021 National Expert Panel reaffirmed system-level goals of ≤5% under-triage and ≤35% over-triage, recommending evidence-based additions/removals guided by likelihood ratios and AUROC (Newgard et al. 2021). Yet, a systematic review of field triage guidelines reported under-triage commonly ranging from 14% to 34% (Lupton et al. 2023).

The Dutch triage-app intervention is encouraging—reducing under-triage without increasing over-triage—but residual rates still exceeded targets, reinforcing the need for ongoing evaluation and local adaptation (Lokerman et al. 2023; Lupton et al. 2023). Consistent with prior reviews and best-practice guidance, triage sensitivity is lower in older populations and mechanisms are often low-energy falls (Boulton et al. 2021; Egodage et al. 2024).

Our included cohort confirmed meaningfully lower sensitivity among adults ≥65 years despite a physician-led system (Benhamed et al. 2023). Practical implications include

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adopting age-attuned thresholds (higher SBP cut-offs, greater weight to GCS decline), lower activation thresholds, and explicit consideration of anticoagulation and comorbidity.

Tool selection and use: Mortality discrimination was excellent for TRISS and mREMS, and strong for MGAP/GAP. NEWS2 achieved its best performance for very early mortality and is better conceptualised as a continuously updated risk signal than a one-off screen (Wei et al. 2023).

Importantly, external validation suggests that models tuned for mortality are not always optimal for identifying major trauma (ISS>15)—the prioritised use case for destination decisions (Sewalt et al. 2020; Gianola et al. 2021). Systems may therefore combine physiology-based tools (GAP/MGAP, mREMS), continuous scores (NEWS2), and mechanism/anatomy cues guided by the 2021 Field Triage Guideline (Newgard et al. 2021).

A hybrid systematic review found wide variation in how the same prehospital variables are operationalised across tools (SBP and GCS thresholds), likely reflecting statistical rather than clinical choices and contributing to inconsistent performance (Donnelly et al. 2025). Harmonising threshold taxonomies—while allowing local calibration—could improve comparability and reduce mistriage.

Limitations: Our review relied on a pre-specified corpus provided by the authors and did not include a de novo literature search. Heterogeneity of designs and endpoints precluded meta-analysis. Nevertheless, the included cohorts, systematic reviews and guidelines span multiple regions and system types, offering a robust cross-section of current evidence.

Implications: Programmes should track under-/over-triage continuously, adopt age-attuned criteria, and consider digital decision support with audit-and-feedback. Where feasible, choose tools with demonstrated discrimination in similar case-mix and recalibrate thresholds locally; use NEWS2 as a dynamic adjunct; and incorporate prehospital Shock Index (including ΔSI) when prolonged transport or occult shock is suspected (Bardes et al. 2023; Yamada et al. 2023).

CONCLUSION

Prehospital triage tools can accurately stratify risk and support destination decisions, with MGAP/GAP, mREMS and TRISS consistently demonstrating strong discrimination and NEWS2 adding value for very early mortality when used as continuous monitoring. However, persistent under-triage—particularly in older adults—and heterogeneous thresholds limit system performance.

Adopting age-attuned criteria, harmonising operational thresholds, integrating digital decision support, and auditing under-/over-triage against guideline targets are pragmatic steps to improve outcomes. Inclusion of prehospital Shock Index (and ΔSI) may be particularly helpful in rural or prolonged-transport contexts.

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