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ACCURACY AND CHALLENGE OF USING THE AUSTRALIAN TRIAGE SCALE (ATS) IN EMERGENCY DEPARTMENTS

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ABSTRACT
The Australian Triage Scale (ATS) is a five-level system widely used in emergency departments (EDs) to categorize patients by urgency and ensure timely care. While ATS has improved efficiency and outcomes in many settings, concerns remain regarding its accuracy, reliability, and applicability across diverse populations. Objective: This narrative review aimed to evaluate the accuracy, reliability, predictive validity, and implementation challenges of ATS in global emergency care. This review followed a structured and systematic literature selection process. A comprehensive search was conducted across six major databases (Scopus, PubMed/MEDLINE, Embase, Cochrane Library, Google Scholar, and SINTA) for studies published between 2010 and 2024. After duplicate removal, titles and abstracts were screened, followed by full-text reviews based on predefined inclusion and exclusion criteria. Methodological quality and relevance were assessed, and 25 studies were included in the final narrative synthesis. These studies were analyzed according to key themes, including accuracy, reliability, predictive validity, training interventions, and implementation challenges of the Australian Triage Scale in emergency departments. Evidence showed that ATS improves outcomes such as reduced mortality and shorter ED length of stay in some contexts. Predictive validity was strongest for high-acuity patients, with a clear mortality gradient across categories. However, reliability was only slight to moderate ($\kappa = 0.25–0.45$), particularly weak in pediatric, psychiatric, and elderly trauma patients. Under-triage was frequent in gastrointestinal bleeding and geriatric trauma, while over-triage was noted in neonates and parental anxiety-driven cases. Training interventions increased accuracy up to 88.4% but decayed without reinforcement. System challenges included overcrowding, variable audit practices, and inconsistent application across hospitals. Comparative reviews found ATS effective overall but less consistent than ESI or MTS in children. A total of 25 studies met the inclusion criteria and were synthesized narratively. ATS remains a core triage framework in emergency care. Its strengths include structured prioritization and outcome prediction in adult populations, but limitations persist in special groups and resource-limited settings. Continuous training, adaptation, and decision-support integration are essential for sustaining accuracy and safety.

Keywords: australian triage scale; emergency department; predictive validity; reliability; triage accuracy

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INTRODUCTION

Emergency departments (EDs) are vital units that manage patients requiring immediate care. The triage process categorizes patients based on urgency to ensure timely interventions. The Australian Triage Scale (ATS) is a widely used tool that divides patients into five categories, determining the ideal time frame for treatment (Farrohknia et al., 2011). Recent global evidence highlights emerging concerns. In Korea, a national analysis of over 20 million ED visits (2016–2020) found that correct triage decreased from 96.8% to 95.7%, with undertriage rising from 2.4% to 3.3% and overtriage from 0.5% to 0.7% over five years (Jung & Yi, 2024). ATS has been applied in Indonesia, to enhance patient prioritization. A quantitative data on ATS-specific undertriage and overtriage remain scarce. A 2022 evaluation of in-house ATS training at H.L. Manambai Abdulkadir Hospital found a 6.7% overtriage rate post-training, alongside a 93.3% correct classification rate (Arundyna, 2024). However, undertriage and overtriage events continue to present challenges, revealing gaps in nurse training, documentation, and clinical decision-making.

The increasing burden on emergency departments due to the rise in acute and critical cases has necessitated a reliable and standardized triage system to streamline patient flow and improve clinical outcomes. Overcrowding in EDs, especially in public hospitals, has been identified as a significant barrier to delivering timely and effective care (Damansyah et al., 2022). Without proper triage, patients with life-threatening conditions may experience treatment delays, while non-urgent patients might consume resources unnecessarily (Rasyid et al., 2024). In this context, the Australasian Triage Scale (ATS) provides a structured framework that prioritizes patients based on clinical urgency and the expected time for physician assessment, categorized into five levels (Australasian College for Emergency Medicine, 2023). By enabling triage nurses to make rapid and consistent decisions, the ATS helps reduce treatment delays and enhance overall emergency department efficiency. Nevertheless, the effectiveness of ATS implementation depends not only on the existence of guidelines but also on competent personnel, regular training, clear protocols, adequate supervision, and supportive infrastructure. Research has highlighted discrepancies in triage accuracy stemming from human and systemic factors, such as limited standardized tools, insufficient clinical experience, heavy workload, and ambiguous patient presentations (Khairina et al., 2020; Khalilati et al., 2022). These challenges may result in undertriage or overtriage, both of which negatively impact patient outcomes and resource allocation (Seo et al., 2024).

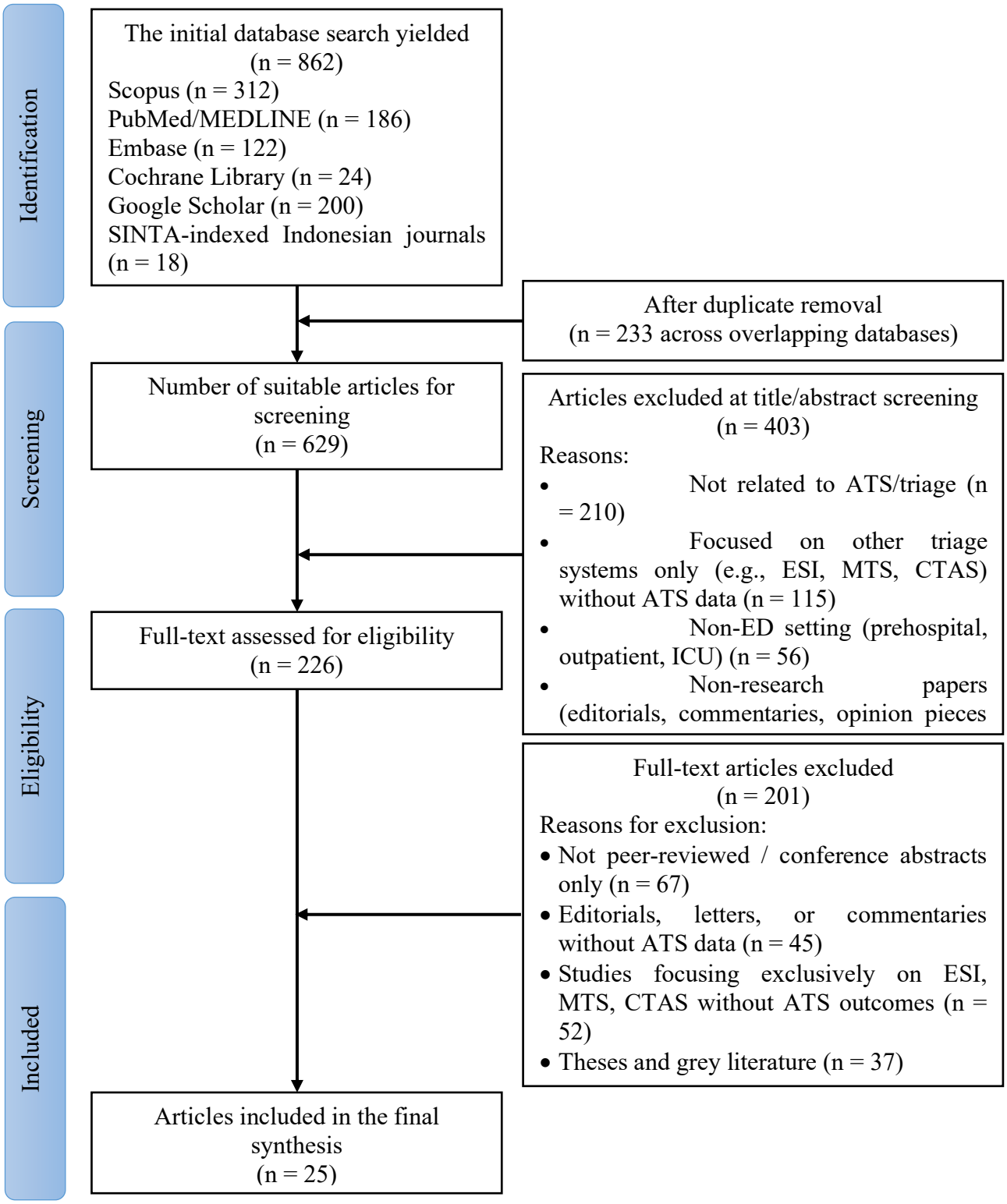
As part of health system strengthening, Indonesia has progressively introduced ATS in many hospitals to promote consistency and quality in emergency care delivery. Yet, implementation across institutions remains uneven, with variations in staff competencies, resource availability, and institutional support (Cahyaningsih & Daely, 2024). Therefore, it becomes essential to evaluate how ATS is being implemented in practice, what challenges are faced by triage nurses, and what strategies can be employed to enhance its accuracy and sustainability, while also systematically assessing its accuracy, reliability, predictive validity, and implementation challenges in global emergency care.

METHOD

A structured literature search was conducted in six databases: Scopus, PubMed/MEDLINE, Embase, Cochrane Library, Google Scholar, and SINTA. The following search terms were applied in different combinations: *"Australian Triage Scale"* OR *"Australasian Triage Scale"* AND (*accuracy* OR *validity* OR *reliability* OR *implementation* OR *emergency department*). The search covered publications from January 2010 to December 2024. Inclusion criteria: (1) Evaluated the accuracy, reliability, validity, outcomes, or implementation challenges of the Australian/Australasian Triage Scale (ATS). (2) Were conducted in Emergency Department settings (adult, pediatric, or mixed). (3) Employed study designs including observational (retrospective or prospective), quasi-experimental, cohort, randomized controlled trials, systematic reviews, or meta-analyses. (4) Were peer-reviewed full-text articles, published in English or Bahasa Indonesia (for SINTA-indexed journals). Exclusion criteria: (1) Editorials, letters to the editor, commentaries, or conference abstracts without full data. (2) Case reports or descriptive series without ATS outcome measures. (3) Focused solely on other triage tools (e.g., ESI, MTS, CTAS) without ATS analysis. (4) Theses, dissertations, or other forms of grey literature.

The initial search identified 862 records: Scopus (312), PubMed/MEDLINE (186), Embase (122), Cochrane Library (24), Google Scholar (200), and SINTA (18). After removing 233 duplicates, 629 unique records remained. During title and abstract screening, 403 studies were excluded as irrelevant (not related to ATS), leaving 226 articles for full-text eligibility assessment. At the eligibility stage, 201 full-text articles were excluded: 67 were not peer-reviewed or only available as conference abstracts, 45 were editorials or commentaries without original ATS data, 52 focused exclusively on other triage systems (ESI, MTS, CTAS), and 37 were theses or grey literature. Finally, 25 studies were included in the narrative synthesis. Of these, 17 were Scopus-indexed, 6 were PubMed-indexed, and 2 were SINTA-indexed Indonesian journals. Studies from Embase,

Cochrane Library, and Google Scholar did not provide unique additional inclusions after de-duplication. The full selection process is detailed:



RESULT

The narrative synthesis included a total of 25 studies conducted between 2004 and 2025, spanning multiple countries and healthcare settings. The regional distribution of these studies was as follows:

1. Australia (n = 10): Considine (2004), Creaton (2008), Allen (2015), Lukin (2015), Varndell (2019), Ha (2021), Santos (2023), McNeil (2023), Ryan (2025), Mitchell (2024).
2. Iran (n = 4): Ebrahimi (2015), Ebrahimi (2020), Ghafarypour (2018), Mirhaghi & Shafee (2019).

3. Egypt (n = 1): Sabry (2023).
4. Greece (n = 2): Pontisidis (2024), Zagalioti (2023).
5. Croatia (n = 1): Sorić (2022).
6. Spain (n = 1): Font-Cabrera (2023).
7. Canada (n = 1): Ouellet (2022).
8. Netherlands (n = 2): Storm-Versloot (2011), Zachariasse (2019).
9. Italy (n = 1): Parenti (2014).
10. Singapore (n = 1): Shen & Lee (2020).
11. Sweden (n = 1): Farrohknia (2011).

These studies investigated various aspects of the Australian Triage Scale (ATS), with major themes including triage accuracy, interrater reliability, training and education, outcomes in special populations such as pediatric, psychiatric, and older adults, as well as system-level implementation challenges.

The thematic grouping of the studies is outlined below:

1. Reliability and Interrater Agreement (n = 9): Considine (2004), Allen (2015), Creaton (2008), Ebrahimi (2015, 2020), Ghafarypour (2018), Parenti (2014), Zachariasse (2019), Mirhaghi (2019).
2. Predictive Validity and Clinical Outcomes (n = 6): Sabry (2023), Lukin (2015), Ryan (2025), Santos (2023), McNeil (2023), Ha (2021).
3. Training and Education (n = 3): Pontisidis (2024), Zagalioti (2023), Allen (2015).
4. Implementation and System Challenges (n = 4): Shen & Lee (2020), Sorić (2022), Varndell (2019), Mitchell (2024).
5. Systematic Reviews and Protocols (n = 3): Farrohknia (2011), Ouellet (2022), Font-Cabrera (2023).

Differences were also observed in follow-up duration and training strategies.

Follow-up duration:

a. Sabry et al. (2023) in Egypt assessed outcomes up to 12 months after ATS implementation.
b. Pontisidis et al. (2024) in Greece measured training effects both immediately after intervention and at three months.
c. Zagalioti et al. (2023) also evaluated accuracy over time and observed a partial decline in performance several months post-training.

Training duration and format:

a. Pontisidis et al. (2024) implemented two workshop sessions lasting approximately three hours each, using case-based learning.
b. Zagalioti et al. (2023) conducted a single, intensive four-hour simulation-based session.
c. Allen et al. (2015) emphasized the need for ongoing pediatric-specific refresher training, especially for less experienced nurses, to sustain accuracy and interrater reliability.

A detailed summary of the selected studies is presented in table:

Table 1.
Analysis article

No.	Author & Year (Country)	Title	Objective	Design	Key Findings
1.	Considine et al., 2004 (Australia) (Considine et al., 2004)	The Australasian Triage Scale: Examining emergency department nurses' performance using computer and paper scenarios	Assess triage reliability by case type & medium	Experimental (scenario-based)	Reliability moderate for adults; pediatric misclassification higher; multimedia influenced decision-making.
2.	Creaton et al., 2008 (Australia) (Creaton et al., 2008)	Interrater reliability of the Australasian Triage Scale for mental health patients.	Test ATS in mental health triage	Observational	Reliability poor for psychiatric patients; suicidal/agitated often under-triaged.

No.	Author & Year (Country)	Title	Objective	Design	Key Findings
3.	Farrohknia et al., 2011 (Sweden) (Farrohknia et al., 2011)	Emergency department triage scales and their components: a systematic review of the scientific evidence.	Systematically review performance, validity and reliability of ED triage scales (including ATS) and their elements.	Systematic review	ATS has predictive validity for severe cases; reliability variable.
4.	Storm-Versloot et al., 2011(Netherlands) (Storm-Versloot et al., 2011)	Comparison of an informally structured triage system, the Emergency Severity Index, and the Manchester Triage System to distinguish patient priority in the emergency department	Compare structured vs informal triage	Comparative validity study	Structured 5-level scales (ATS, ESI, MTS) more accurate than informal system.
5.	Parenti et al., 2014 (Italy) (Parenti et al., 2014)	A systematic review on the validity and reliability of an emergency department triage scale, the Manchester Triage System.	Review ATS vs other scales	Systematic review	ATS less consistent than MTS/ESI; methodological gaps noted.
6.	Allen et al., 2015 (Australia) (Allen et al., 2015)	Accuracy and interrater reliability of paediatric emergency department triage	Evaluate ATS in children	Observational	Weak–moderate reliability; high acuity recognized; non-specific complaints under-triaged.
7.	Lukin et al., 2015 (Australia) (Lukin et al., 2015)	Triaging older major trauma patients in the emergency department: an observational study.	Compare ATS categorization by age	Retrospective trauma registry study	Older patients less likely to receive ATS Cat. 1–2 despite higher severity; associated with delayed treatment and higher mortality. Highlights age bias in ATS.
8.	Ebrahimi et al., 2015 (Iran) (Ebrahimi et al., 2015)	The reliability of the Australasian Triage Scale: A meta-analysis	Measure ATS consistency among nurses	Meta-analysis	Interrater reliability $\kappa \approx 0.45$; errors frequent in Cat. 3; training improved agreement.
9.	Varndell et al., 2019 (Australia) (Varndell et al., 2019)	Triage in Australian emergency departments: Results of a New South Wales survey.	Explore triage practice and audits	Cross-sectional survey	Variation in ATS use; inconsistent feedback; barriers: overcrowding & staffing.
10.	Mirhaghi & Shafaee., 2019 (Iran) (Mirhaghi & Shafaee, 2019)	Poorly developed scenarios may interface with reliability of triage scales	Critique on methods	Commentary	Vignette studies may misrepresent ATS reliability; live audits recommended.
11.	Zachariasse et al., 2019 (Netherlands) (Zachariasse et al., 2019)	Performance of triage systems in emergency care: a systematic review and meta-analysis	Assess sensitivity/specificity for urgent cases	Systematic review/meta-analysis	ATS effective for urgent detection; but trade-offs in under/over-triage.
12.	Ebrahimi et al., 2020 (Iran) (Ebrahimi et al., 2020)	Are pediatric triage systems eeliable in the emergency department?	Meta-analysis of pediatric ATS reliability	Systematic review/meta-analysis	$\kappa = 0.25–0.31$ (slight agreement); ATS under-triaged febrile/nonspecific complaints.

No.	Author & Year (Country)	Title	Objective	Design	Key Findings
13.	Shen & Lee, 2020 (Singapore) (Shen & Lee, 2020)	Improving the wait time to triage at the emergency department	Reduce waiting time to triage	Retrospective manner and the operational nature of the data collected,	Wait-to-triage decreased 18 → 13 min ($p<0.01$). ATS compliance improved from 72% → 88%. Breaches in Cat. 2 fell significantly.
14.	Ghafarypour et al., 2018 (Iran) (Ghafarypour-Jahrom et al., 2018)	Validity and reliability of the Emergency Severity Index and Australasian Triage System in pediatric emergency care of Mofid Children's Hospital in Iran.	Compare ATS vs ESI	Prospective observational	ESI outperformed ATS in <5 y.o.; ATS sensitivity lower for admission.
15.	Sabry et al., 2023 (Egypt) (Sabry et al., 2023)	Impact of implementing five-level triage system on patients outcomes and resource utilization in the emergency department of Alexandria main university hospital	Evaluate ATS implementation on mortality, LOS, resource use	Observational (pre/post)	Mortality ↓5.26%→1.46%; LOS ↓170→72 min; fewer unnecessary labs.
16.	Sorić, 2022 (Croatia) (Sorić, 2022)	Effect of the introduction of emergency medicine specialists on the emergency department performance indicators: A retrospective data analysis	Assess EM specialist impact on ATS outcomes	Retrospective cohort	ATS compliance ↑; LOS ↓147→94 min; reduced unnecessary imaging.
17.	Ha et al., 2022 (Australia) (Ha et al., 2021)	The use of computed tomography in the management of injury in tertiary emergency departments in Western Australia: Evidence of overtesting?	Explore CT use across ATS categories	Retrospective cohort	Overuse of CT in ATS 4–5; low yield; linked to mis-triage.
18.	Ouellet et al., 2022 (Canada) (Ouellet et al., 2022)	Strategies to improve the quality of nurse triage in emergency departments: A realist review protocol	Map interventions to improve triage	Protocol	Proposed framework: training + feedback + decision support → improved accuracy.
19.	Font-Cabrera et al., 2023 (Spain) (Font-Cabrera et al., 2023)	Implementation of advanced triage in the emergency department of high complexity public hospital: Research protocol	Describe advanced nurse triage program	Protocol	Algorithm-based triage + advanced training. Outcomes planned: LOS, ATS compliance, mortality.
20.	Santos et al., 2023 (Australia) (Santos et al., 2023)	Characteristics of non-urgent neonatal presentations to an Australian metropolitan emergency department	Describe ATS Cat. 4–5 neonatal cases	Retrospective audit	Most neonates triaged Cat. 4–5; discharged without tests; parental anxiety main issue.
21.	McNeil et al., 2023 (Australia) (McNeil et al., 2023)	Is this child suitable to be seen in primary care? Poor agreement between caregiver/family perception and definitions of a 'primary care-type' patient	Compare caregiver vs ATS categorization	Prospective cohort	Poor caregiver–ATS agreement; parental anxiety → overestimation of urgency.
22.	Zagalioti et al., 2023 (Greece)	The first positive evidence that training	Determine effect of an education	Pre/post intervention	Significant accuracy improvement; effect

No.	Author & Year (Country)	Title	Objective	Design	Key Findings
	(Zagalioti et al., 2023)	improves triage decision-making in Greece	intervention on triage performance in ED nurses		declined over time; ongoing training recommended.
23.	Mitchell et al., 2025 (Australia) (Mitchell et al., 2024)	Systematic review: What is the impact of triage implementation on clinical outcomes and process measures in low- and middle-income country emergency departments?	Assess triage outcomes (mortality, LOS)	Systematic review	Triage reduced wait times & improved treatment time; mortality effect mixed.
24.	Ryan et al., 2025 (Australia) (Ryan et al., 2025)	Evaluation of the Australian Triage Scale in patients who present to the emergency department with upper gastrointestinal bleeding	Assess ATS accuracy vs clinical severity	Retrospective observational	>50% unstable GI bleed patients under-triaged (ATS 3–5).
25.	Pontisidis et al., 2024 (Greece) (Pontisidis et al., 2024)	Effect of triage training on nurses with Emergency Severity Index and Australian triage scale: A quasi-experimental study	Assess training effect on accuracy & knowledge	Quasi-experimental	Accuracy ↑62.3%→88.4% after training; declined to 74.2% at 3 months.

Reliability of the Australian Triage Scale (ATS)

Multiple studies assessed the interrater reliability of the ATS across adult, pediatric, and psychiatric populations. Considine et al. (2004) demonstrated that while adult scenarios yielded moderate agreement, pediatric cases were frequently misclassified, and presentation format (paper vs multimedia) influenced nurse decisions(Considine et al., 2004). Allen et al. (2015) confirmed weak-to-moderate reliability in pediatric EDs, with high-acuity cases identified more consistently than non-specific complaints such as fever and vomiting(Allen et al., 2015). Ebrahimi et al. (2015, 2020) conducted meta-analyses pooling pediatric and mixed-population studies, reporting κ values between 0.25 and 0.45, reflecting only slight to moderate agreement(Ebrahimi et al., 2015, 2020). Reliability was lowest in pediatric and psychiatric contexts, as shown by Creaton et al. (2008), where suicidal or agitated patients were often under-triaged. Storm-Versloot et al. (2011) and Parenti et al. (2014) highlighted that ATS performed less consistently than structured alternatives such as the Manchester Triage System (MTS) or the Emergency Severity Index (ESI). Collectively, these studies indicate that ATS reliability is variable and population-dependent, with greatest weaknesses in children, psychiatric cases, and intermediate categories(Creaton et al., 2008; Parenti et al., 2014; Storm-Versloot et al., 2011).

Predictive Validity and Clinical Outcomes

Several studies evaluated whether ATS categories correlate with patient outcomes such as mortality, hospital admission, and resource utilization. Sabry et al. (2023) demonstrated that ATS implementation in Egypt reduced ED mortality (from 5.26% to 1.46%) and length of stay (170.1 to 72 minutes), while also lowering unnecessary investigations(Sabry et al., 2023). However, Ryan et al. (2025) found that more than half of patients with hemodynamic compromise due to gastrointestinal bleeding were under-triaged (ATS 3–5), suggesting poor sensitivity for this subgroup (Ryan et al., 2025). Lukin et al. (2015) similarly showed that older trauma patients were less likely to be categorized as ATS 1–2, despite greater injury severity and higher mortality, indicating age-related under-triage(Lukin et al., 2015). McNeil et al. (2023) and Santos et al. (2023) further showed that parental anxiety and neonatal presentations often resulted in mismatched categorization, with many non-urgent neonates assigned Cat. 4–5 and discharged without interventions. These findings suggest that while ATS demonstrates predictive validity in general

adult populations, its performance is inconsistent for elderly, gastrointestinal, and neonatal patients(McNeil et al., 2023; Santos et al., 2023).

Training and Education Interventions

A consistent theme across the literature is that targeted education improves ATS accuracy but requires reinforcement. Pontisidis et al. (2024) reported accuracy improved from 62.3% → 88.4% after training, but declined to 74.2% after 3 months. The program included two scenario-based workshops of ~3 hours each(Pontisidis et al., 2024). Zagalioti et al. (2023) also documented significant improvements in triage accuracy post-training, with partial decay over time, reinforcing the need for ongoing education. He found similar improvements after simulation-based training, but accuracy partially decayed over time, highlighting the need for regular refresher courses(Zagalioti et al., 2023). Allen et al. (2015) echoed this, noting that training particularly benefits less experienced nurses, Allen noted training was particularly beneficial for nurses with <5 years of experience(Allen et al., 2015). Varndell et al. (2019), through a statewide survey in New South Wales, highlighted inconsistent training and auditing practices across EDs, with overcrowding and staffing shortages impeding ATS fidelity. Collectively, these findings confirm that structured, scenario-based education and regular audit-feedback loops are essential to sustaining ATS reliability (Varndell et al., 2019). These results underscore that ATS effectiveness is strongly dependent on ongoing, structured refresher training every 3–6 months, using simulation and case-based learning to maintain reliability.

Implementation Challenges and Resource Utilization

Studies also evaluated ATS within the context of ED workflow, resource allocation, and system-level outcomes. Shen and Lee (2020) demonstrated that process redesign (dedicated triage nurse, electronic ATS) reduced wait-to-triage times and improved compliance with ATS targets(Shen & Lee, 2020). Sorić (2022) reported that the presence of emergency medicine specialists improved triage accuracy, shortened ED stay (147 to 94 minutes), and reduced unnecessary imaging(Sorić, 2022). Ha et al. (2022) found CT scans overused in ATS categories 4–5, often linked to defensive practice or mis-triage, emphasizing the need for stronger guideline adherence(Ha et al., 2021). Mitchell et al. (2020), in a review of LMIC emergency departments, concluded that triage implementation consistently reduced waiting times and improved time-to-treatment, though mortality benefits were mixed due to confounding factors. Collectively, these studies show that ATS effectiveness depends on system design, staffing expertise, and adherence monitoring(Mitchell et al., 2024).

Comparative Evidence and Methodological Critiques

Systematic reviews by Farrohknia et al. (2011) and Zachariasse et al. (2019) consistently concluded that ATS shows reasonable validity for high-acuity cases but lower reliability than comparators such as ESI and MTS(Farrohknia et al., 2011; Zachariasse et al., 2019). Ghafarypour et al. (2018) specifically demonstrated that ESI outperformed ATS in pediatric EDs in Iran, particularly in children under five. Mirhaghi and Shafaee (2019) critiqued the widespread reliance on vignette studies, arguing they lack clinical nuance and may overestimate reliability compared to live audits(Ghafarypour-Jahrom et al., 2018). Ouellet et al. (2022) and Font-Cabrera et al. (2023) presented protocols for realist and advanced triage interventions, highlighting ongoing efforts to strengthen ATS through training, decision support, and algorithm-based enhancements(Font-Cabrera et al., 2023; Ouellet et al., 2022).

DISCUSSION

The evidence synthesized in this review highlights both the strengths and the persistent challenges in using the Australasian Triage Scale (ATS) in emergency departments. Across diverse geographic and clinical contexts, ATS has been shown to function as an essential tool for prioritizing patients,

particularly in adult general emergency care, yet the variability in its reliability and predictive validity raises concerns about its universality and its applicability to specific subgroups of patients. Taken together, the results suggest that while ATS provides a structured framework that has been widely adopted, its accuracy is highly context-dependent, influenced by patient characteristics, the clinical setting, and the expertise of the triage provider.

One of the most consistent findings across the literature is the variability in interrater reliability. Early experimental studies such as those by Considine and colleagues demonstrated moderate levels of agreement, but with noticeable weaknesses in pediatric scenarios (Considine et al., 2004). Later observational work reinforced this trend, as Allen and colleagues found that nurses were more consistent in assigning ATS categories to high-acuity pediatric presentations than to children presenting with non-specific or ambiguous symptoms (Allen et al., 2015). Meta-analyses by Ebrahimi and others further quantified this limitation, reporting κ values that rarely exceeded 0.45, with the weakest performance in pediatric and psychiatric cohorts. This indicates that ATS, while structured, still leaves significant room for subjective interpretation, particularly when applied to populations where clinical presentations are complex or atypical. Such variability undermines the very purpose of standardized triage, which is to ensure equity and timeliness of care regardless of who performs the initial assessment (Ebrahimi et al., 2015).

Despite these reliability concerns, several studies demonstrated that ATS categories retain predictive value for important clinical outcomes. For instance, Sabry and colleagues documented significant reductions in mortality and length of stay after ATS was implemented in a large Egyptian hospital(Sabry et al., 2023). Gräff and co-workers similarly showed a clear gradient of mortality across ATS categories, suggesting that, at a population level, ATS successfully stratifies patients according to risk. These findings align with the fundamental intent of triage systems: to allocate limited resources efficiently and to ensure that critically ill patients are prioritized. However, the predictive validity of ATS is not uniformly strong. Ryan and colleagues found that patients with upper gastrointestinal bleeding, many of whom were hemodynamically unstable, were frequently under-triaged into lower categories, delaying time-sensitive interventions(Ryan et al., 2025). Similarly, Lukin and collaborators reported that older trauma patients, despite having more severe injuries, were less likely to be categorized in the most urgent ATS levels compared to younger counterparts(Lukin et al., 2015). These findings expose a structural limitation in the scale: it may inadequately capture severity in subgroups whose clinical presentations differ from the prototypical patterns upon which the scale was originally designed.

Training and education emerged as crucial determinants of ATS performance. Evidence from Pontisidis and Zagalioti consistently showed that structured training programs significantly improved triage accuracy, but these effects decayed over time without reinforcement(Pontisidis et al., 2024) (Zagalioti et al., 2023). This phenomenon was further corroborated by Varndell's survey, which revealed wide disparities in how Australian emergency departments delivered training and provided feedback. Inconsistent audit mechanisms and a lack of structured refresher programs meant that many nurses relied on intuition or local practices, which in turn increased variability. While education is not a panacea for the limitations of ATS, it is evident that without sustained and standardized training, even the inherent strengths of the system cannot be fully realized(Varndell et al., 2019). Moreover, these findings highlight a paradox: the ATS was designed to be simple and reproducible, yet its effective application still depends heavily on ongoing education and contextual adaptation.

The implementation studies also shed light on how ATS interacts with systemic factors in emergency care. Shen and Lee demonstrated that wait times to triage were reduced when workflow redesign was implemented, showing that organizational changes can amplify the effectiveness of ATS(Shen & Lee, 2020). Likewise, the presence of emergency medicine specialists, as reported by

Sorić, was associated with higher compliance rates and shorter length of stay, suggesting that expertise at the triage desk is as important as the scale itself(Sorić, 2022). At the same time, the misuse of diagnostic imaging, particularly CT scans for low-acuity ATS categories as observed by Ha and colleagues, underscores the risk of resource overutilization when triage misclassification occurs. These system-level consequences highlight the dual role of ATS: it is not only a clinical tool but also a determinant of how resources are distributed within an already strained emergency system(Ha et al., 2021).

A recurring challenge across the studies is the tension between under-triage and over-triage. Under-triage is particularly dangerous because it delays life-saving interventions for patients who are in fact critically ill, as shown in gastrointestinal bleeding, geriatric trauma, and psychiatric emergencies. Over-triage, while less dangerous in terms of immediate clinical risk, creates strain by diverting resources toward patients who could safely wait. Mirhaghi's systematic review and the comparative evidence from Storm-Versloot and Parenti confirm that ATS, compared with systems such as ESI or MTS, tends to underperform in balancing this trade-off, with higher rates of mis-triage especially in non-classical presentations. This raises the important question of whether ATS should remain the gold standard across all contexts, or whether hybrid systems, condition-specific modifications, or decision-support technologies should be integrated to improve accuracy(Mirhaghi & Shafaee, 2019) (Storm-Versloot et al., 2011) (Parenti et al., 2014).

Several authors have critiqued the methodological foundations upon which ATS evidence is built. Mirhaghi and Shafaee, for example, argued that vignette-based studies may overestimate reliability by failing to capture the nuances of real-life emergency presentations, where patients present with incomplete or misleading histories. This critique is important because many of the reliability studies included in meta-analyses relied heavily on scenarios rather than real patients. While scenarios offer a controlled means of comparison, they may not reflect the complexity of patient encounters, particularly when dealing with ambiguous or overlapping symptom clusters. This suggests that future research should prioritize live patient audits and prospective validation studies that better approximate clinical reality(Mirhaghi & Shafaee, 2019).

Another important dimension is cultural and health system context. Studies from Egypt and Iran revealed unique challenges in applying ATS outside its country of origin. In Egypt, ATS implementation markedly improved outcomes, but this success may not be generalizable to all low- and middle-income countries because it was coupled with significant organizational changes. It showed successful ATS outcomes, but this was accompanied by systemic changes including increased staffing and structured oversight(Sabry et al., 2023). In Iran, comparative studies showed that ESI outperformed ATS in pediatric care, raising questions about whether ATS is the most appropriate system for settings with a high pediatric caseload. These cross-national findings highlight the importance of not treating ATS as a one-size-fits-all instrument. And found ESI outperformed ATS in children under 5 years old, leading to suggestions for modified pediatric triage approaches(Ghafarypour-Jahrom et al., 2018). These findings show that ATS cannot simply be transplanted; it requires cultural adaptation and contextual modification depending on patient demographics, staffing levels, and institutional capacity.

The issue of patient and caregiver perception also complicates the application of ATS. McNeil and colleagues highlighted poor agreement between parental assessment of urgency and ATS categorization, demonstrating how anxiety and expectations drive non-urgent visits to emergency departments(McNeil et al., 2023). Santos and colleagues similarly found that many neonates triaged into lower categories presented with feeding difficulties and parental concerns rather than acute illness(Santos et al., 2023). These findings reveal a gap between the clinical rationale underlying ATS and the lived reality of patient presentation. Triage systems that fail to account for this discrepancy may perpetuate overcrowding and dissatisfaction, even if they function well in strictly clinical terms.

Looking at the broader picture, systematic reviews by Farrohknia and Zachariasse emphasized that five-level triage systems as a whole, including ATS, are superior to informal or three-level systems in terms of structure and predictive validity. However, their analyses also pointed out that variability in training, local modifications, and methodological inconsistencies across studies make it difficult to draw definitive conclusions about ATS's superiority over other scales. The reviews also underscored the importance of linking triage performance to patient outcomes rather than merely measuring agreement among raters, a recommendation that future ATS research should take seriously(Farrohknia et al., 2011) (Zachariasse et al., 2019).

What emerges from this synthesis is a paradoxical picture. On one hand, ATS has demonstrable benefits: it reduces mortality and waiting times in some contexts, provides a reproducible structure for categorizing patients, and offers a foundation upon which staff training and system improvements can build. On the other hand, its weaknesses are also stark: poor reliability in pediatrics and psychiatry, under-triage of elderly trauma and gastrointestinal bleeding, dependence on ongoing training, and susceptibility to systemic factors such as crowding and staffing shortages. These contradictions suggest that ATS should not be seen as a fixed standard but rather as a dynamic tool that requires continual adaptation, evaluation, and support.

The implications for practice are significant. Emergency departments that rely on ATS should invest in regular training and refresher programs, incorporate condition-specific modifications for vulnerable groups, and consider augmenting human decision-making with electronic decision-support systems. System-level interventions, such as staffing triage with experienced emergency medicine specialists or redesigning workflows to reduce wait times, can enhance the effectiveness of ATS beyond what the scale alone can achieve. Policymakers and administrators should also be aware of the cultural and contextual factors that influence ATS performance, ensuring that implementation is accompanied by appropriate adaptation rather than direct transplantation.

From a research perspective, there is a clear need for more live patient studies that evaluate ATS performance in real time and link triage decisions to clinical outcomes. Comparative trials that directly test ATS against other scales in different populations would also provide valuable insights. Furthermore, qualitative studies exploring the experiences of triage nurses, patients, and caregivers could deepen understanding of how ATS operates not only as a technical tool but also as a social process shaped by expectations, anxieties, and institutional cultures.

CONCLUSION

This study demonstrates a significant association between Systemic Immune-Inflammation Index (SII) and Systemic Inflammation Response Index (SIRI) with the occurrence of major adverse cardiac events (MACE) during hospitalization in patients with acute myocardial infarction. While both indices were associated with MACE, only SIRI showed an independent predictive value, indicating its potential utility as a simple, inexpensive, and accessible prognostic biomarker for early risk stratification in clinical settings. These findings support the concept that inflammatory and immune responses play a crucial role in the pathophysiology and short-term outcomes of AMI. The integration of SIRI into clinical risk assessment may enhance early identification of high-risk patients and guide more intensive monitoring and management strategies, particularly in resource-limited hospitals. Further prospective, multicenter studies with larger sample sizes are needed to validate these results and explore their prognostic value in different populations.

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