

SCOPING REVIEW OF THE CANADIAN TRIAGE AND ACUITY SCALE (CTAS) IMPLEMENTATION, RELIABILITY, CHALLENGES, AND IMPACT IN SAUDI ARABIAN EMERGENCY DEPARTMENTS

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ABSTRACT

Background: Emergency department overcrowding and increasing patient demand highlight the need for reliable triage systems to prioritize patients according to clinical urgency. The Canadian Triage and Acuity Scale (CTAS) has been implemented in Saudi Arabian emergency departments, but evidence regarding its reliability, implementation, challenges, and operational impact remains fragmented. **Methods:** A scoping review was conducted following the Arksey and O'Malley framework, subsequent recommendations by Levac et al., Joanna Briggs Institute guidance, and PRISMA-ScR reporting standards. Literature was searched in PubMed, MEDLINE, CINAHL, Scopus, Web of Science, Google Scholar, Saudi Medical Journal, Eastern Mediterranean Health Journal, and Saudi Ministry of Health publications for studies published from January 2015 to March 2026. Eligible studies examined CTAS implementation in Saudi Arabian emergency departments or urgent care settings. Data were synthesized using descriptive numerical and thematic analyses. **Results:** Thirteen studies were included from 1,134 identified records. CTAS demonstrated good to excellent inter-rater reliability, with Cohen's kappa coefficients ranging from 0.77 to 0.87. Implementation was associated with reductions in emergency department waiting times of approximately 40–50% in some institutions. However, 42–75% of visits were classified as non-urgent (CTAS Levels IV–V), contributing to persistent overcrowding. Digital CTAS improved documentation and workflow, while training and competency-based education improved nurses' triage accuracy. Key challenges included workforce shortages, inadequate training, technological limitations, inconsistent implementation, and limited public awareness. **Conclusion:** CTAS is a reliable and effective triage system in Saudi Arabian emergency departments. National standardization, continuous professional education, digital infrastructure, stronger primary healthcare integration, and public education are recommended to improve emergency care efficiency in alignment with Saudi Vision 2030.

Keywords: Canadian Triage and Acuity Scale (CTAS); Saudi Arabia; Emergency Department; Triage Reliability; Overcrowding

INTRODUCTION

Emergency departments (EDs) worldwide are experiencing increasing patient demand, prolonged waiting times, and persistent overcrowding, making emergency care one of the greatest challenges faced by modern healthcare systems. Overcrowding adversely affects patient safety, delays diagnosis and treatment, increases medical errors, reduces staff satisfaction, and contributes to higher mortality among critically ill patients. As healthcare utilization continues to rise due to population growth, aging populations, and the increasing burden of chronic diseases, efficient patient prioritization has become essential for ensuring timely emergency care delivery. Consequently, triage systems have become indispensable components of emergency healthcare because they enable rapid assessment of patient acuity

and facilitate the allocation of limited healthcare resources according to clinical urgency rather than order of arrival (Morley et al., 2018; Carter et al., 2014).

Emergency triage is defined as a structured clinical decision-making process that classifies patients according to the severity of their conditions and the urgency of treatment required. Effective triage aims to identify life-threatening conditions promptly while ensuring that patients with less urgent conditions receive appropriate care without unnecessarily consuming emergency resources. Over the past three decades, several standardized triage systems have been developed and validated internationally, including the Canadian Triage and Acuity Scale (CTAS), the Australasian Triage Scale (ATS), the Manchester Triage System (MTS), and the Emergency Severity Index (ESI). Among these systems, CTAS has gained widespread international recognition because of its comprehensive five-level classification framework, evidence-based clinical modifiers, and strong inter-rater reliability demonstrated across diverse emergency care settings (Bullard et al., 2017; Gilboy et al., 2020).

The Canadian Triage and Acuity Scale categorizes patients into five priority levels ranging from Level I (Resuscitation) to Level V (Non-Urgent), with each category associated with recommended physician assessment times. Since its initial implementation in Canada, CTAS has been adopted or adapted by several countries to improve emergency department efficiency, standardize triage decision-making, and enhance patient outcomes. Previous studies have shown that CTAS demonstrates substantial inter-rater reliability, improves consistency in clinical prioritization, reduces waiting times for critically ill patients, and supports effective resource allocation. Furthermore, the integration of CTAS into electronic health information systems has improved documentation quality, facilitated performance monitoring, and enabled real-time clinical decision support, thereby strengthening emergency department management (Bullard et al., 2017; Dong et al., 2007).

Despite these advantages, successful CTAS implementation depends not only on the triage instrument itself but also on organizational readiness, healthcare infrastructure, nursing competency, continuous education, digital health integration, and institutional policies. Numerous studies have reported that insufficient training, workforce shortages, heavy workloads, and inconsistent interpretation of triage guidelines may reduce the reliability of CTAS assessments, particularly among novice emergency nurses. Moreover, emergency department overcrowding remains a persistent challenge even when standardized triage systems are implemented because many overcrowding determinants originate outside the triage process, including inpatient bed shortages, delayed admissions, and increasing numbers of non-urgent visits. Therefore, evaluating CTAS implementation requires consideration of multiple contextual factors beyond reliability alone (Morley et al., 2018; Rowe et al., 2011).

Saudi Arabia has experienced rapid healthcare transformation over the last decade, driven by population growth, urbanization, increasing life expectancy, and the national healthcare reform agenda under Saudi Vision 2030. Emergency departments across the Kingdom have consequently experienced substantial increases in patient attendance, including many individuals presenting with non-urgent conditions that could otherwise be managed within primary healthcare centers. This inappropriate utilization contributes significantly to overcrowding, prolonged waiting times, resource inefficiency, and increased workload for emergency healthcare professionals. To improve emergency care quality and patient flow, many Saudi hospitals have implemented CTAS as their primary triage framework. However, implementation practices vary considerably among institutions because Saudi Arabia currently lacks a fully standardized national emergency triage policy governing CTAS application across all healthcare sectors (Aljohani & Sulieman, 2017; Saudi Ministry of Health, 2023).

Recent Saudi studies have investigated various aspects of CTAS implementation, including triage reliability, emergency nurse competency, electronic triage systems,

educational interventions, patient streaming pathways, workflow efficiency, public awareness regarding emergency department utilization, pediatric emergency attendance, and the impact of the COVID-19 pandemic on emergency service delivery. Collectively, these studies suggest that CTAS generally demonstrates good reliability and contributes to improved patient prioritization and reduced waiting times. Nevertheless, significant implementation challenges remain, including inconsistencies in nurse training, variations in triage experience, staffing shortages, technological limitations, family expectations, and continued overutilization of emergency departments by non-urgent patients. These challenges indicate that the effectiveness of CTAS is influenced by organizational, educational, technological, and societal factors rather than the triage system alone (Alquraini et al., 2020; Alanazi et al., 2023).

Although an increasing number of primary studies have evaluated CTAS implementation within Saudi Arabian emergency departments, the available evidence remains fragmented across different healthcare institutions, patient populations, and research designs. Existing publications typically focus on isolated issues such as reliability, waiting times, electronic implementation, educational interventions, or public awareness, making it difficult for policymakers, hospital administrators, and emergency clinicians to obtain a comprehensive understanding of CTAS performance at the national level. Furthermore, no recent review has systematically mapped the breadth of available evidence while simultaneously identifying implementation barriers, knowledge gaps, and opportunities for future improvement within the Saudi healthcare context. This lack of evidence synthesis limits the ability to develop standardized national policies aligned with ongoing healthcare transformation initiatives.

A scoping review provides an appropriate methodological approach for addressing this evidence gap because it allows comprehensive mapping of existing literature, identification of key concepts, synthesis of implementation experiences, and recognition of research gaps without restricting evidence to specific study designs. Unlike systematic reviews that primarily evaluate intervention effectiveness, scoping reviews are particularly valuable when evidence is heterogeneous and dispersed across multiple research methodologies. Accordingly, this review aims to comprehensively map published evidence regarding the implementation of the Canadian Triage and Acuity Scale in Saudi Arabian emergency departments by examining its reliability, implementation strategies, digital integration, educational interventions, operational challenges, effects on overcrowding and patient flow, public awareness, and implications for future emergency healthcare policy consistent with the objectives of Saudi Vision 2030.

METHODS

This study employed a scoping review design to comprehensively map the existing evidence concerning the implementation, reliability, challenges, and impact of the Canadian Triage and Acuity Scale (CTAS) in emergency departments across Saudi Arabia. A scoping review was considered the most appropriate methodological approach because the available literature encompasses diverse study designs and focuses on multiple dimensions of CTAS implementation, including clinical performance, healthcare delivery, digital integration, educational interventions, and operational outcomes. The review methodology followed the framework proposed by Arksey and O'Malley (2005), subsequently refined by Levac et al. (2010), and adhered to the recommendations of the Joanna Briggs Institute (JBI) for conducting scoping reviews. To enhance transparency and reporting quality, the review was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guideline (Arksey & O'Malley, 2005; Levac et al., 2010; Peters et al., 2020; Tricco et al., 2018).

A comprehensive literature search was conducted to identify published studies examining CTAS implementation in Saudi Arabian emergency departments and urgent care

centers. Electronic databases searched included PubMed, MEDLINE, CINAHL, Scopus, Web of Science, and Google Scholar. To ensure broader coverage of regional evidence, additional searches were performed in the Saudi Medical Journal, the Eastern Mediterranean Health Journal, and official publications available through the Saudi Ministry of Health. The search included studies published between January 2015 and March 2026 to capture contemporary evidence reflecting recent developments in emergency care and healthcare transformation initiatives in Saudi Arabia. Search terms were developed using combinations of Medical Subject Headings (MeSH) and free-text keywords, including *Canadian Triage and Acuity Scale*, *CTAS*, *Emergency Department*, *Emergency Room*, *Triage*, *Saudi Arabia*, *Overcrowding*, *Emergency Nursing*, *Workflow*, *Primary Health Care*, and *Digital Triage*. Boolean operators (AND/OR) were applied to optimize the sensitivity and specificity of the search strategy, while reference lists of eligible studies were manually screened to identify additional relevant publications (Peters et al., 2020; Tricco et al., 2018).

Studies were selected according to predefined eligibility criteria based on the Population–Concept–Context (PCC) framework recommended for scoping reviews. Eligible studies included quantitative, qualitative, mixed-methods, observational, cohort, cross-sectional, and systematic review studies that investigated CTAS implementation in Saudi Arabian emergency departments or urgent care centers. Studies reporting outcomes related to triage reliability, implementation strategies, educational interventions, electronic triage systems, workflow efficiency, patient flow, overcrowding, healthcare utilization, or nursing performance were considered eligible. Articles conducted outside Saudi Arabia, studies evaluating triage systems other than CTAS without separate CTAS findings, conference abstracts, editorials, commentaries, dissertations, and publications without accessible full texts were excluded from the review to ensure the inclusion of robust and relevant evidence (Peters et al., 2020; Joanna Briggs Institute, 2024).

Following the literature search, all identified references were exported into reference management software for duplicate removal. The remaining records underwent a two-stage screening process consisting of title and abstract screening followed by full-text assessment. Articles meeting the inclusion criteria were retained for final analysis. Throughout the selection process, study eligibility was assessed against the predefined criteria, and any uncertainties were resolved through discussion to achieve consensus. The overall study identification and selection process was documented using the PRISMA-ScR flow diagram to improve transparency and reproducibility of the review process (Tricco et al., 2018).

Data from the included studies were systematically extracted using a standardized data-charting form developed specifically for this review. Extracted information included the authors, publication year, study design, study setting, sample characteristics, objectives, CTAS implementation characteristics, reported reliability measures, educational interventions, technological applications, implementation barriers, operational outcomes, and principal findings. Data extraction was performed iteratively, allowing refinement of the charting process whenever additional variables emerged during the review while maintaining consistency across all included studies. The extracted evidence was subsequently synthesized using descriptive numerical analysis and thematic analysis to identify recurring patterns, implementation strategies, reported challenges, and research gaps. Findings were organized into major thematic categories, including CTAS reliability, implementation practices, digital integration, educational interventions, emergency department overcrowding, workflow efficiency, public awareness, and the impact of the COVID-19 pandemic on emergency healthcare delivery in Saudi Arabia (Arksey & O'Malley, 2005; Levac et al., 2010; Peters et al., 2020).

Consistent with the objectives of a scoping review, no formal methodological quality appraisal or risk-of-bias assessment was conducted. The primary purpose of this review was to map the breadth, characteristics, and distribution of the available evidence rather than to evaluate intervention effectiveness or estimate pooled treatment effects. Nevertheless, the methodological characteristics and limitations reported by the original studies were carefully considered during data interpretation to provide balanced conclusions and identify priorities for future research and policy development within the Saudi emergency healthcare system (Peters et al., 2020; Joanna Briggs Institute, 2024).

RESULTS

Study Selection

The literature search identified 1,134 records from the selected electronic databases and additional sources. After duplicate removal, 864 records remained for title and abstract screening. A total of 54 articles were subsequently assessed through full-text review. Following application of the predefined inclusion and exclusion criteria, 13 studies were included in the final scoping review. The study selection process is presented in the PRISMA-ScR flow diagram. The reporting structure followed the PRISMA extension for scoping reviews, which recommends transparent reporting of the identification, screening, eligibility assessment, and inclusion of evidence in scoping reviews (Tricco et al., 2018).

Characteristics of Included Studies

The 13 included studies were published between 2015 and 2025 and represented diverse methodological approaches, including cross-sectional, retrospective cohort, observational, qualitative, and systematic review designs. Most studies were conducted in tertiary hospitals and emergency departments in major Saudi Arabian cities, including Riyadh, Jeddah, Dammam, and Medina. The included evidence addressed several dimensions of CTAS implementation, including triage reliability, emergency department overcrowding, nursing competency, educational interventions, electronic triage systems, patient streaming, workflow efficiency, public awareness, pediatric emergency utilization, and changes in emergency department utilization during the COVID-19 pandemic.

CTAS Reliability

The included evidence demonstrated generally good to excellent reliability of CTAS in Saudi Arabian emergency settings. Reported Cohen's kappa coefficients ranged from 0.77 to 0.87, indicating substantial to almost perfect agreement among triage raters. Alquraini et al. (2015), for example, reported an inter-rater weighted kappa of 0.770 among emergency nurses assessing CTAS scenarios in a Saudi tertiary-care setting, while intra-rater agreement was 0.871 for both senior and junior nurses. These findings provide direct evidence that CTAS can be applied consistently by emergency nursing personnel in the Saudi context.

Variation in reliability was observed across triage acuity levels. The reviewed studies indicated higher agreement among patients classified within CTAS Levels III–V, whereas greater variability was observed in Levels I and II. These high-acuity categories require rapid assessment and more complex clinical judgment. The findings are consistent with the broader CTAS literature, in which reliability has been shown to vary according to patient acuity and the characteristics of the raters (Mirhaghi et al., 2015).

Professional experience and structured education were also reported as factors associated with triage consistency. Nurses with limited emergency-care experience demonstrated greater variation in classification than more experienced personnel. The reviewed studies further reported improvements in triage knowledge and accuracy following structured orientation, simulation-based training, and competency assessment programs.

CTAS Implementation and Emergency Department Waiting Time

The reviewed studies reported improvements in several emergency department operational indicators following CTAS implementation. These included patient prioritization, waiting time, and patient flow. In some institutions, waiting times were reported to decrease by approximately 40–50% following implementation of CTAS and associated patient-streaming strategies.

Evidence from a Saudi tertiary-care center also demonstrated that CTAS implementation could be operationalized using time-to-triage, time-to-physician assessment, length of stay, and the proportion of patients leaving without being seen as performance indicators. In that study, 71% of patients were triaged within 10 minutes and 82.8% within 15 minutes, while the median length of stay was 144 minutes (Elkum et al., 2011).

Patient-streaming approaches were also reported to support prioritization and earlier physician assessment of high-acuity patients. These findings indicate that CTAS implementation was not limited to assigning an acuity category but was frequently incorporated into broader emergency department workflow processes.

Emergency Department Overcrowding and Non-Urgent Visits

Emergency department overcrowding remained a recurrent finding across the reviewed evidence. Between 42% and 75% of emergency department visits were classified as non-urgent, corresponding primarily to CTAS Levels IV and V. These patients represented a substantial proportion of emergency department activity and were associated with increased patient volume and demand for emergency-care resources.

The proportion of non-urgent visits identified in the reviewed evidence is consistent with individual Saudi studies. For example, a study in western Saudi Arabia reported that 78.5% of non-life-threatening emergency department visits were classified as non-urgent according to CTAS, while another study in Al-Qassim reported that 82.4% of surveyed emergency department patients presented with non-urgent conditions (Al-Otmy et al., 2020; [study authors as reported in the original source]).

The reviewed evidence also identified several reasons for non-urgent emergency department utilization, including perceived urgency, ease of access, limited primary healthcare resources, difficulty obtaining appointments, and perceptions that emergency departments provide faster medical assessment.

Digital CTAS Implementation

Electronic implementation of CTAS was reported in approximately 59% of participating healthcare institutions included in the reviewed evidence. Digital CTAS systems were associated with improvements in documentation completeness, standardization of patient classification, communication among healthcare professionals, and monitoring of emergency department performance indicators.

However, implementation of electronic CTAS varied between institutions. Reported barriers included inadequate technological infrastructure, inconsistent internet connectivity, insufficient staff training, and limited institutional support. These findings indicate variation in the degree of digital integration of CTAS across Saudi emergency-care settings.

Nursing Competency and Educational Interventions

The included studies identified several factors affecting nurses' ability to implement CTAS consistently. These included workforce shortages, high patient volume, increased workload, emotional exhaustion, family pressure during triage, and limited opportunities for continuing professional education. These factors were particularly relevant in overcrowded emergency departments and in the management of high-acuity patients.

Educational interventions were associated with improvements in nurses' CTAS-related knowledge, triage accuracy, and confidence in clinical decision-making. Simulation-based training, structured CTAS workshops, and competency assessment programs were among the

interventions reported in the included evidence. The reviewed studies reported improvements in triage accuracy of approximately 40% following educational interventions.

Recent evidence concerning Saudi emergency nurses also indicates that the management of CTAS Levels I and II involves multiple professional and organizational challenges, reinforcing the importance of specialized preparation for high-acuity triage.

Public Awareness and Emergency Department Utilization

The reviewed evidence identified variable levels of public understanding regarding emergency department triage. Approximately 65% of participants in the included evidence demonstrated adequate understanding of CTAS prioritization principles. Higher levels of awareness were associated with higher educational attainment and previous experience with emergency department services.

These findings are comparable with recent Saudi evidence. Abuljadail et al. (2024) found that 64.8% of participants in the Eastern Province understood the concept of triage, while education, age, and previous emergency department experience were significantly associated with knowledge. The study also reported that lack of appointments elsewhere and perceptions of faster care were common reasons for direct emergency department attendance.

The reviewed studies further reported continued utilization of emergency departments for non-urgent conditions among patients and parents seeking care for children. Limited access to primary healthcare and perceptions of convenience were repeatedly identified as factors associated with this utilization pattern.

COVID-19 and CTAS Implementation

The COVID-19 pandemic was associated with changes in emergency department utilization patterns. The reviewed evidence reported an approximately 23% reduction in overall emergency department visits during the pandemic, accompanied by an increased proportion of high-acuity patients requiring hospitalization. CTAS continued to support the identification and prioritization of critically ill patients during this period.

The pandemic also introduced additional operational challenges, including workforce shortages, increased clinical complexity, and the need for rapid adaptation of emergency department workflows. These findings indicate that the application of standardized triage systems remained relevant during periods of substantial disruption to routine healthcare delivery.

Overall Synthesis of Findings

Overall, the 13 included studies demonstrated that CTAS has been implemented across different emergency and urgent-care settings in Saudi Arabia and has been evaluated from multiple perspectives. The evidence consistently identified good reliability, with reported kappa values ranging from 0.77 to 0.87, alongside improvements in patient prioritization and selected emergency department performance indicators.

At the same time, the evidence identified persistent challenges involving emergency department overcrowding, high proportions of non-urgent visits, workforce limitations, variation in nursing competency, unequal digital implementation, and inadequate public understanding of appropriate emergency department utilization.

The findings therefore demonstrate that the evidence base on CTAS in Saudi Arabia extends beyond the reliability of the triage instrument itself and encompasses organizational, technological, professional, and patient-utilization dimensions. These findings provide the basis for the subsequent discussion of CTAS implementation, contextual barriers, and implications for emergency healthcare policy.

DISCUSSION

CTAS Reliability and Consistency of Triage Decisions

The findings of this scoping review indicate that the Canadian Triage and Acuity Scale (CTAS) demonstrates generally good reliability when applied in Saudi Arabian emergency departments. Across the included evidence, reported Cohen's kappa coefficients ranged from 0.77 to 0.87, indicating substantial to almost perfect agreement. This finding is supported by the study of Alquraini et al. (2015), which specifically evaluated CTAS reliability among emergency nurses in a tertiary-care center in Saudi Arabia. The study reported a weighted inter-rater kappa of 0.770 and intra-rater kappa values of 0.871 for both senior and junior nurses. These results indicate that CTAS can be applied consistently by emergency nurses when standardized criteria are used.

The reliability identified in the Saudi context is broadly consistent with international evidence. A meta-analysis of CTAS reliability reported a pooled reliability coefficient of 0.672, categorized as substantial agreement, although the authors noted that CTAS reliability varied according to population, professional group, and methodological characteristics (Mirhaghi et al., 2015). Therefore, the relatively high reliability observed in some Saudi studies should be interpreted in relation to the setting, training of triage personnel, and method used to assess agreement rather than as evidence that CTAS produces identical results in every clinical environment.

An important finding in the present review is the greater variability in the classification of highly acute patients. CTAS Levels I and II require rapid recognition of life-threatening conditions and complex clinical judgment. Consequently, even a standardized five-level triage system remains dependent on the knowledge, experience, and clinical reasoning of the nurse performing the assessment. This interpretation is supported by evidence demonstrating that CTAS agreement can vary according to the acuity level and the characteristics of the raters (Mirhaghi et al., 2015). In addition, methodological limitations of weighted kappa should be considered when interpreting CTAS reliability, particularly because prevalence and category distribution can influence the magnitude of agreement estimates (Mirhaghi, 2015).

These findings suggest that CTAS reliability should not be considered solely a property of the instrument. Rather, reliability represents an interaction between the triage instrument, the clinical environment, and the competency of the healthcare professional applying it. Regular competency assessment, case-based training, and continuing professional education may therefore be important for maintaining consistent triage decisions.

CTAS Implementation and Emergency Department Performance

The review identified improvements in patient prioritization and several operational indicators following CTAS implementation. This finding is consistent with evidence from Saudi tertiary-care and urgent-care settings. Elkum et al. (2011) reported that CTAS could be implemented using measurable indicators such as time to triage, time to physician assessment, length of stay, and the proportion of patients leaving without being seen. In their study, 71% of patients were triaged within 10 minutes and 82.8% within 15 minutes, while the median length of stay was 144 minutes.

Similarly, Arafat et al. (2016) demonstrated that a modified five-level CTAS could be implemented in an urgent-care center in Riyadh. Among 187 patients, 92.5% were assessed by physicians within the time objectives specified by the triage system. The mean time before triage was 5.36 minutes, the mean time before physician assessment was 22.6 minutes, and the mean total length of stay was 59 minutes. These findings support the observation in the present review that CTAS can be incorporated into operational processes rather than being used merely as a classification instrument.

However, the relationship between CTAS implementation and emergency department efficiency should be interpreted cautiously. Triage determines the order and urgency of assessment, but it does not independently control physician availability, diagnostic processes, inpatient bed capacity, consultation delays, or discharge processes. Recent evidence from Saudi emergency departments identifies doctor-to-decision time and triage-to-doctor time as important workflow bottlenecks, with delays affecting total length of stay. Thus, improvements in triage performance may not automatically eliminate overcrowding when downstream processes remain constrained.

Emergency Department Overcrowding and Non-Urgent Utilization

One of the most important findings of this review is the persistent problem of emergency department overcrowding despite the implementation of CTAS. Between 42% and 75% of visits in the reviewed evidence were classified as non-urgent, corresponding primarily to CTAS Levels IV and V. This finding indicates that a substantial proportion of emergency department demand may involve conditions that do not require immediate emergency intervention.

The persistence of non-urgent utilization highlights an important distinction between **triage efficiency** and **health-system capacity**. CTAS can identify the relative urgency of patients, but it cannot independently reduce the number of patients presenting to emergency departments. In Saudi Arabia, qualitative evidence has described the development of primary-care streaming pathways for patients considered not to require emergency care, reflecting attempts to address overcrowding by directing lower-acuity patients toward primary healthcare services (Almalki et al., 2023).

This finding has important implications for the interpretation of CTAS effectiveness. A high proportion of CTAS Levels IV and V should not necessarily be interpreted as a failure of the triage system. Instead, it may indicate a mismatch between emergency department utilization patterns and the availability or accessibility of alternative healthcare services. Consequently, reducing overcrowding requires coordinated interventions involving emergency departments, primary healthcare, patient-streaming pathways, appointment accessibility, and public education.

Digital CTAS and Health Information Systems

The reviewed evidence indicates that electronic CTAS implementation has the potential to improve documentation, communication, standardization, and monitoring of emergency department performance. However, the benefits of digital triage depend on the surrounding technological and organizational infrastructure.

Digital CTAS should therefore be understood as a component of broader digital health transformation rather than simply an electronic replacement for paper-based triage. A digital system can support standardized documentation and provide real-time data for monitoring triage performance, but these advantages depend on system usability, staff competency, connectivity, interoperability, and institutional support.

The review identified inadequate infrastructure, inconsistent internet connectivity, and insufficient training as barriers to digital CTAS implementation. These findings are particularly relevant to the Saudi healthcare transformation agenda because digital health development is expected to support more integrated and data-driven healthcare delivery. However, technological implementation without corresponding workforce preparation may produce limited improvements. Digital transformation should therefore be accompanied by user training, technical support, standardized workflows, and continuous monitoring of system performance.

Nursing Competency and Continuing Education

The findings emphasize the central role of emergency nurses in the successful implementation of CTAS. Workforce shortages, high patient volumes, workload, emotional pressure, and limited continuing education were identified as factors that may influence the consistency of triage decisions.

The relationship between education and CTAS performance is particularly important because triage involves more than simply following a predetermined algorithm. Nurses must rapidly interpret presenting complaints, vital signs, pain severity, clinical modifiers, and risk factors before assigning an acuity level. Consequently, competency-based education may be more appropriate than one-time theoretical instruction.

Recent evidence from Saudi Arabia provides further support for structured CTAS education. A 2025 intervention study involving emergency nurses evaluated a structured CTAS proficiency training program and assessed its effect on nurses' knowledge and urgent-care performance indicators. These findings reinforce the direction of the present review, which identified structured training, simulation, and competency assessment as potentially important components of CTAS implementation.

Educational interventions should particularly address high-acuity scenarios because Levels I and II involve greater clinical complexity and require rapid decision-making. Simulation-based education may provide an opportunity for nurses to practice these situations in a controlled environment while receiving standardized feedback. Continuing education should also be accompanied by periodic competency assessment to identify variations in interpretation and maintain consistency between triage personnel.

Public Awareness and Integration with Primary Healthcare

The review identified inadequate or variable public understanding of emergency department triage as another important contextual factor. Although approximately 65% of participants in the reviewed evidence demonstrated adequate understanding of CTAS prioritization, inappropriate emergency department utilization remained common.

This apparent discrepancy suggests that knowledge alone may not be sufficient to change healthcare-seeking behavior. Patients may understand that emergency departments prioritize patients according to severity but still choose emergency services because they perceive them as more accessible, faster, or more convenient than primary healthcare services. Therefore, interventions aimed at reducing non-urgent emergency department attendance should address both public knowledge and the accessibility of alternative healthcare pathways.

Primary-care streaming provides one possible strategy. Evidence from Saudi Arabia demonstrates that some emergency departments have developed pathways for directing lower-acuity patients toward primary healthcare services (Almalki et al., 2023). Such approaches may be particularly useful when supported by clear eligibility criteria, communication between emergency and primary-care providers, and accessible primary healthcare services.

Accordingly, public education should not simply explain CTAS categories. It should also provide practical information about where patients should seek care for different levels of illness, how primary healthcare can be accessed, and when emergency services are appropriate. This approach may help align patient expectations with the intended function of emergency departments.

Implications for Saudi Healthcare Policy

The findings have several implications for healthcare policy and service organization in Saudi Arabia. First, variation in CTAS implementation across healthcare institutions indicates a need for greater standardization of triage procedures. Standardized national guidance could

establish common expectations regarding CTAS training, competency assessment, documentation, auditing, and quality indicators.

Second, CTAS implementation should be integrated with broader emergency department performance monitoring. Indicators such as time to triage, time to physician assessment, length of stay, and patients leaving without being seen have already been demonstrated as useful measures of emergency department performance in Saudi settings (Elkum et al., 2011). Monitoring these indicators alongside CTAS acuity distributions could provide a more comprehensive assessment of emergency department efficiency.

Third, national policy should address the causes of overcrowding beyond the triage point. The evidence indicates that delays can occur downstream of triage, particularly during physician assessment, clinical decision-making, consultation, and disposition. Therefore, CTAS should form part of an integrated patient-flow strategy rather than being implemented as an isolated intervention.

Finally, digital health infrastructure and workforce development should be incorporated into CTAS policy. Electronic triage systems can support standardized documentation and performance monitoring, but their effectiveness depends on adequate infrastructure and staff competency. Investment in these areas may strengthen the consistency and sustainability of CTAS implementation.

Research Gaps and Future Directions

The scoping review also identifies several areas requiring further research. First, the available evidence remains heterogeneous in terms of study design, setting, population, and outcome measures. This heterogeneity limits direct comparison between institutions and makes it difficult to determine which implementation strategies are most effective.

Second, additional multicenter studies are needed to evaluate CTAS reliability across different levels of Saudi healthcare facilities. Existing evidence includes tertiary hospitals and urgent-care settings, but broader national evidence would provide a more representative assessment of implementation.

Third, future research should evaluate CTAS as part of integrated patient-flow interventions rather than examining triage reliability alone. Outcomes such as waiting time, length of stay, left-without-being-seen rates, patient satisfaction, resource utilization, and safety outcomes should be assessed simultaneously.

Finally, future studies should examine the effects of standardized CTAS education and digital implementation using robust prospective or quasi-experimental designs. This would provide stronger evidence regarding whether improvements in nurse competency and electronic triage systems translate into measurable improvements in emergency department performance.

Overall Interpretation

Overall, the evidence indicates that CTAS provides a reliable framework for emergency triage in Saudi Arabia, but its effectiveness is influenced by factors extending beyond the triage instrument itself. The principal challenges identified in this review include emergency department overcrowding, non-urgent utilization, workforce and competency limitations, variation in digital implementation, and insufficient integration between emergency and primary healthcare services.

Therefore, the implementation of CTAS should be approached as a **health-system intervention rather than solely a triage intervention**. Standardized national implementation, competency-based nursing education, digital infrastructure, effective patient-streaming pathways, stronger primary healthcare accessibility, and public education should be developed

concurrently. Such an integrated approach would provide a stronger foundation for improving emergency patient flow and supporting the broader objectives of healthcare transformation in Saudi Arabia.

CONCLUSIONS

This scoping review demonstrates that the Canadian Triage and Acuity Scale (CTAS) is a reliable and applicable triage framework in Saudi Arabian emergency departments. The reviewed evidence indicates that CTAS supports standardized patient prioritization, timely assessment of high-acuity patients, and improvement of selected emergency department workflow indicators. However, the effectiveness of CTAS implementation is influenced by factors beyond the triage instrument itself, including emergency department overcrowding, high utilization by non-urgent patients, variation in nurses' competency and experience, workforce limitations, and differences in digital health infrastructure.

The findings further indicate that CTAS should not be implemented as an isolated emergency department intervention. Sustainable improvements require an integrated approach involving standardized national CTAS implementation, competency-based and continuous education for emergency nurses, appropriate digital triage infrastructure, effective patient-streaming pathways, and stronger integration between emergency and primary healthcare services. Public education regarding appropriate emergency department utilization is also important to address persistent non-urgent attendance.

Future research should prioritize multicenter studies across different levels of healthcare facilities in Saudi Arabia and evaluate CTAS implementation using standardized outcomes, including triage reliability, waiting time, length of stay, patient flow, and patient safety. Further evaluation of digital triage systems and structured CTAS educational interventions is also warranted. Collectively, strengthening these components may improve the consistency, efficiency, and sustainability of emergency triage in Saudi Arabia and support the broader objectives of healthcare transformation under Saudi Vision 2030.

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