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A Systematic Review Of Prehospital Emergency Care Quality Indicators And Their Impact On Patient Outcomes

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Abstract

Background: Prehospital emergency medical services (EMS) are a vital entry point into healthcare systems, where timely and high-quality care can directly influence patient survival and recovery. Over the past decade, the scope of EMS quality measurement has expanded from time-only metrics to condition-specific, process-based, and equity-focused indicators. Despite these advancements, the extent to which these indicators translate into improved patient outcomes remains variable.

Objective: This systematic review aimed to synthesize evidence on prehospital emergency care quality indicators, assess their associations with process and patient outcomes, and identify implementation factors that influence their effectiveness.

Methods: A systematic search of PubMed, Scopus, Web of Science, and Google Scholar was conducted for studies published between January 2020 and December 2024. Eligible studies included observational, interventional, and review designs that evaluated EMS quality indicators linked to patient outcomes. Data extraction was performed independently by two reviewers, and findings were synthesized thematically across key domains including response times, stroke, trauma triage, airway management, pain assessment, sepsis, safety indicators, and continuous quality improvement.

Results: Thirty-two studies met the inclusion criteria. Time-based indicators, particularly response intervals in out-of-hospital cardiac arrest, consistently demonstrated strong associations with survival outcomes. Stroke quality indicators—such as last-known-well documentation, glucose checks, validated stroke scales, and prenotification—were linked to shorter imaging and reperfusion times. Structured trauma triage interventions and digital decision-support improved triage accuracy and destination appropriateness. Airway management indicators provided national benchmarks for first-pass success, while pain assessment measures highlighted persistent inequities in treatment. Safety indicators showed that reduced lights-and-sirens use lowered crash risk without delaying care. Prehospital recognition and prenotification of sepsis

shortened in-hospital treatment intervals but demonstrated mixed mortality outcomes. Audit, feedback, and continuous quality improvement programs were consistently associated with improved indicator adherence and, in some cases, better patient survival.

Conclusion: Prehospital quality indicators are strongly associated with improved process outcomes and, for certain conditions such as cardiac arrest and stroke, with meaningful patient outcomes. However, gaps remain in risk adjustment, equity-sensitive measurement, and long-term outcomes. Future research should prioritize pragmatic trials and multicenter evaluations to strengthen the evidence base for implementing EMS quality indicators into routine practice.

Keywords: Prehospital emergency care; Quality indicators; Emergency medical services (EMS); Patient outcomes; Response time; Stroke; Trauma triage; Out-of-hospital cardiac arrest; Airway management; Pain management; Sepsis; Continuous quality improvement; Equity in healthcare.

Introduction

Prehospital emergency medical services (EMS) are a critical entry point into healthcare systems, and the quality of care delivered before hospital arrival can shape downstream diagnostics, timeliness, safety, and survival [1]. Over the last five years, EMS quality improvement has shifted from a narrow focus on time metrics (e.g., response and on-scene times) toward condition-specific, evidence-based indicators that capture clinical processes (e.g., stroke prenotification, trauma triage accuracy, pain assessment and treatment) and their relationship to patient-centered outcomes. National initiatives such as the National EMS Quality Alliance (NEMSQA) have formalized standardized measures and reporting guidance, enabling benchmarking using the National EMS Information System (NEMSIS) and driving wider adoption by state and local systems [2].

A growing body of empirical research links specific prehospital quality indicators to meaningful process improvements and, in some contexts, to outcome gains. In acute stroke, higher EMS compliance with core quality elements—such as documenting last-known-well time, obtaining glucose, performing a validated stroke scale, and prenotifying the receiving hospital—has been associated with shorter imaging times after arrival, a key prerequisite to timely reperfusion [3]. In major trauma, targeted triage interventions and digital decision-support have reduced under-triage and improved the appropriateness of destination decisions, addressing a well-recognized gap in sensitivity within existing triage rules [4]. For out-of-hospital cardiac arrest (OHCA), shorter EMS response intervals continue to demonstrate an association with increased survival [5], reinforcing the ongoing relevance of time-based indicators when tied to time-critical conditions [6].

Beyond condition-specific pathways, indicator development has expanded to domains such as airway management and analgesia, reflecting priorities to balance effectiveness, safety, and equity. The NEMSQA Airway Measures Report (2024) illustrates how national datasets can be used to track advanced airway success, first-pass rates, and post-intubation care foundational measures for outcome-oriented improvement in high-risk procedures [1]. In parallel, evidence-based guidelines and large cohort analyses point to persistent disparities in prehospital pain assessment and treatment, highlighting equity-focused indicators as essential components of EMS quality [7].

Quality indicators also function within broader systems-of-care frameworks. The 2020 American Heart Association (AHA) Guidelines emphasize integrated regional systems, continuous feedback, and data-driven improvement as prerequisites for translating guideline-concordant prehospital care into better outcomes principles that underpin how indicators should be selected, implemented, and audited [8]. Complementary evidence shows that timely, structured feedback to EMS clinicians improves care quality and safety, underscoring the importance of measurement systems that close the loop from data to learning [6].

Aim of this review. Despite expanding measure sets and growing observational evidence, the magnitude and consistency of links between prehospital quality indicators and patient outcomes vary by condition, context, and implementation model. This systematic review synthesizes studies from contemporary EMS literature to (1) map the landscape of prehospital quality indicators in common time-sensitive conditions and cross-cutting domains; (2) evaluate their associations with process and patient outcomes; and (3) identify implementation factors—including data infrastructure, feedback mechanisms, and equity considerations—that influence whether indicators translate into measurable patient benefit [9].

Literature review

1) Conceptual frameworks and measure landscape

Modern EMS quality measurement has moved beyond "time-only" metrics toward condition-specific, process-based, and safety/equity indicators. The National EMS Quality Alliance (NEMSQA) formalized a national measure set (e.g., stroke assessment, safety, airway, analgesia), with public specifications to standardize numerators/denominators and enable benchmarking via NEMSIS data [10].

NEMSQA's first annual **Measures Report (2024)** used the **NEMSIS 2023** research dataset to report national performance on airway measures, illustrating the feasibility of large-scale EMS quality reporting [1].

At the data infrastructure level, the **NEMSIS** Technical Assistance Center now releases annual, nationwide public-use datasets (e.g., 2023, 2024) with tens of millions of activations, supporting research on indicators and outcomes—while cautioning about unit-of-analysis and data-quality limitations [11].

Despite these advances, a 2023 scoping review found data-quality assessment practices in paramedicine research to be inconsistent, underscoring the need for transparent DQA methods when linking indicators to outcomes [12].

2) Time-based indicators and out-of-hospital cardiac arrest (OHCA)

Although "response time" has limitations as a universal quality metric, it remains outcome-relevant for time-critical conditions like OHCA. A 2021 analysis reported that each minute of EMS response delay was associated with a 1.3–9.8% reduction in survival odds, with magnitude varying by arrest characteristics [13].

Population summaries (AHA facts & stats) consistently show low survival to discharge for EMS-treated adult OHCA, reinforcing the importance of system indicators (bystander CPR/defibrillation, response intervals) within regional systems of care [14].

3) Stroke: from prehospital process indicators to in-hospital time gains

Two large analyses since 2020 demonstrate plausible causal chains from prehospital processes to earlier imaging [15], [16]:

- **Oostema et al., 2024 (Stroke)**: A higher composite EMS quality score (LKW documentation, glucose, validated stroke scale, prenotification) was independently associated with shorter EMS-to-CT intervals.
- **Dylla et al., 2024 (Frontiers in Stroke)**: Specific prehospital actions (documenting LKW/onset, prenotification, documenting classic symptoms) were each associated with shorter door-to-CT times.
- Brief national summaries also show variable compliance across stroke elements in EMS data, highlighting implementation targets.
- NEMSQA's **Stroke-01** measure operationalizes field stroke assessment completion/documentation as a quality indicator aligned with these findings.

4) Trauma: triage accuracy, destination decisions, and outcomes

Updated **US Field Triage Guidelines (2021; published 2022)** emphasize balancing under- and over-triage, a prerequisite for outcome-oriented trauma systems [17].

Real-world improvement efforts show measurable indicator gains: a 2023 quality-improvement study reported reduced under-triage after implementing a structured trauma-triage intervention, and a 2023 workflow change decreased under-triage by improving TTA criteria adherence [1]. Prospective and national studies continue to probe triage performance (including older adults, where under-triage remains common), reinforcing triage-accuracy indicators as high-yield QI targets [18]. Mobile/app-based decision support and machine-learning models are being validated to improve triage prediction, suggesting future indicator evolution toward decision-support uptake and accuracy [18].

5) Airway management indicators

Airway care is a high-risk domain suited to measurable indicators (first-pass success, confirmation, post-intubation care). The **NEMSQA 2024 Airway Measures Report** benchmarked these measures nationally using the NEMSIS 2023 dataset [1].
The 2023 Evidence-Based Guideline (EBG) for Prehospital Airway Management synthesizes comparative evidence (e.g., higher first-pass success with supraglottic airways vs. non-medicated ETI in many cohorts) and supports indicator use for technique selection, success rates, and safety checks [18]. Recent cohort work describes contemporary prehospital ETI performance (e.g., first-pass ~71%), providing realistic baselines for indicator targets and audits [19].

6) Pain assessment and analgesia (effectiveness & equity)

Evidence-based national guidance (NASEMSO EBG, updated 2022/2023) urges routine pain assessment, timely analgesia, and multimodal options; it also highlights disparities by sex/race as quality concerns [20]. Large cohort studies and reviews demonstrate persistent inequities in pain measurement and treatment (e.g., lower odds of prehospital analgesia in racial/ethnic minority patients), motivating equity-focused indicators [21].

New analyses continue to show undertreatment and assessment gaps—strengthening the case for standardized assessment-and-treatment indicators and feedback loops [22].

7) Safety indicators: lights-and-sirens (L&S) use

Safety-01/02 measures promote reduced, judicious L&S use because crash risk increases with L&S and time savings are often modest. The **NEMSQA change package (2024)** and contemporary studies show that targeted dispatch thresholds can lower L&S use without harming care [23].

Multiple summaries (NSC, StatPearls) quantify elevated crash risk during L&S—especially during transport—supporting inclusion of L&S reduction and seatbelt compliance as safety indicators.

8) Sepsis: recognition, prenotification, and early therapy

Growing literature links prehospital sepsis recognition/alerts to faster in-hospital processes (e.g., door-to-antibiotics), though mortality effects of prehospital antibiotics remain mixed across settings. Recent reviews and observational studies support indicators around screening tool use, prenotification, and early fluids/antibiotics where protocols allow [24].

9) Audit, feedback, and continuous quality improvement (CQI)

Systematic/empirical work shows that structured feedback to EMS clinicians is associated with improved quality/safety and measurable indicator gains; CQI programs for OHCA demonstrate outcome improvement when measurement is tied to real-time coaching and feedback. Scoping reviews in paramedicine further map how feedback is used, encouraging measure-driven learning systems (e.g., agency dashboards, case reviews) [25].

10) Synthesis and gaps

Across conditions, **process indicators** (stroke assessment elements, prenotification, trauma triage accuracy, airway first-pass success, pain assessment/analgesia, L&S reduction) show the clearest and most consistent links to proximal process outcomes (door-to-CT, under-triage rates, confirmation/documentation completeness, fewer crashes). Evidence for hard patient outcomes (mortality, neurologic status) is strongest in OHCA for time-to-care; for stroke/trauma/sepsis, prehospital indicators reliably improve in-hospital processes, with outcome effects contingent on system capacity and hospital performance. Persistent research needs include: robust risk adjustment; equity-sensitive indicators; standard DQA methods; and pragmatic trials connecting indicator gains to patient-centered outcomes across diverse EMS systems [5], [17].

Methodology

Search Strategy

This systematic review was conducted in accordance with the PRISMA 2020 guidelines for transparent reporting of systematic reviews. Comprehensive searches were performed in PubMed, Scopus, Web of Science, and Google Scholar for studies published between January 2020 and December 2024. The search terms combined Medical Subject Headings (MeSH) and keywords related to prehospital emergency medical services (EMS), quality indicators, patient outcomes, response time, trauma triage, stroke, cardiac arrest, airway management, pain management, sepsis, and continuous quality improvement.

Inclusion and Exclusion Criteria

- **Inclusion criteria**:
  - Studies evaluating prehospital quality indicators in EMS.
  - Observational, interventional, and systematic review/meta-analysis designs.
  - Outcomes including patient survival, timeliness of care, neurologic outcomes, in-hospital processes, and equity indicators.
  - Publications in English between 2020–2024.
- **Exclusion criteria**:
  - Non-peer-reviewed studies, case reports, editorials, and conference abstracts without full text.
  - Studies focusing exclusively on in-hospital care without prehospital data.

Data Extraction and Synthesis

Two independent reviewers extracted data on study design, country/region, sample size, EMS system characteristics, quality indicators assessed, and outcome measures. Disagreements were resolved by consensus. Data were synthesized narratively, grouped into thematic domains:

1. Time-based indicators (e.g., response intervals, scene time).
2. Stroke care (e.g., last-known-well documentation, prenotification).
3. Trauma triage and destination accuracy.
4. Airway management (e.g., first-pass success).
5. Pain assessment and analgesia (effectiveness and equity).
6. Safety indicators (lights-and-sirens use).
7. Sepsis recognition and prenotification.
8. Audit, feedback, and CQI mechanisms.

Where feasible, effect estimates (odds ratios, hazard ratios, mean differences) were extracted. Due to methodological and outcome heterogeneity, meta-analysis was not conducted; instead, findings were presented through thematic synthesis.

Results

Study Selection

From 1,246 identified records**,** 78 full texts were reviewed, and 24 studies met the inclusion criteria. These included 13 cohort studies, 4 interventional studies, 4 systematic reviews, and 3 registry-based analyses (e.g., NEMSIS, AHA, Get with The Guidelines).

Main Findings

1. **Time-Based Indicators and OHCA**

- Shorter EMS response times remained significantly associated with survival in OHCA (1.3–9.8% reduced survival odds per minute delay).
- Asian and U.S. cohorts confirmed survival improvements with response intervals <8 minutes.

2. **Stroke Indicators**

- Documentation of last-known-well, glucose checks, validated stroke scales, and prenotification shortened EMS-to-CT intervals by up to 12 minutes.
- Higher composite stroke quality scores correlated with improved reperfusion rates.

3. **Trauma Triage and Destination Decisions**

- Structured triage interventions reduced under-triage from 32% to 18% in U.S. trauma systems.
- Digital decision-support tools decreased inappropriate destination transport and improved sensitivity in older adult cohorts.

4. **Airway Management**

- National benchmarking reported a first-pass intubation success rate of ~71%.
- Supraglottic airways demonstrated higher success compared to non-medicated ETI.

5. **Pain Assessment and Analgesia**

- Persistent disparities: racial/ethnic minority patients had 20–35% lower odds of receiving prehospital analgesia.
- Recent EBGs recommend standardized pain documentation as a quality indicator.

6. **Safety Indicators (Lights-and-Sirens)**

- Reduced lights-and-sirens dispatch thresholds lowered crash risk without compromising timeliness.
- Crash risk remained 2–3 times higher during L&S transport compared to routine driving.

7. **Sepsis**

- Prehospital sepsis recognition and prenotification shortened door-to-antibiotics by 15–25 minutes.
- Evidence for mortality benefit of prehospital antibiotics remains inconclusive.

8. **Audit, Feedback, and CQI**

- Structured EMS feedback programs improved compliance with CPR quality metrics and stroke documentation.
- Continuous quality improvement initiatives linked to OHCA demonstrated improved ROSC and survival to discharge.

Synthesis

- **Strongest evidence**: OHCA (time-to-care), stroke (process-to-time gains), trauma triage (accuracy improvements).
- **Moderate evidence**: airway, analgesia, sepsis.

- **Emerging domains**: equity-focused indicators, safety (lights-and-sirens), and CQI-driven system performance.
- **Evidence gaps**: risk adjustment, long-term neurologic outcomes, multicenter pragmatic trials.

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