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PREHOSPITAL STROKE TRIAGE: A COMPARATIVE REVIEW OF FIELD SCREENING TOOLS FOR THE EARLY IDENTIFICATION OF ACUTE STROK

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Abstract:

Background: *Stroke remains a leading cause of death and disability worldwide, with time-to-treatment critically influencing outcomes. The emergence of endovascular thrombectomy (EVT) for large vessel occlusion (LVO) has increased the need for accurate prehospital stroke identification and triage. Emergency medical services (EMS) personnel use field screening tools to recognize stroke, exclude mimics, and guide destination decisions.*

Objective: *This review evaluates the diagnostic performance, clinical utility, and implementation of widely used prehospital stroke screening tools for early acute stroke identification.*

Methods: *A systematic search of PubMed/MEDLINE, Scopus, Web of Science, and the Cochrane Library was conducted from inception through December 2024. Studies evaluating prehospital stroke screening tools in adults with suspected acute stroke assessed by EMS were included. A narrative synthesis was adopted due to heterogeneity.*

Results: *A consistent sensitivity–specificity trade-off exists across tools. Simpler tools (CPSS, FAST) offer high sensitivity (78-85%) but lower specificity (76-82%). Comprehensive tools (LAPSS, MASS) offer higher specificity (88-94%) but lower sensitivity (75-86%). LVO-specific tools (RACE, FAST-ED, C-PSSS) offer balanced performance (78-82% sensitivity, 82-84% specificity). All tools have lower sensitivity for posterior circulation strokes (45-60%) versus anterior (75-90%). Screening improves notification rates (to 70-90%), reduces door-to-needle time (15-30 min), and increases thrombolysis (10-25%). LVO tools enable accurate transport (75-85%) and reduce time-to-EVT by 45-60 min.*

Conclusions: *No single tool is optimal for all settings. Selection should consider stroke prevalence, transport times, hospital capabilities, and EMS training. A tiered approach may be optimal. Future research should prioritize comparative studies, posterior stroke detection, and technology integration.*

Keywords:*Prehospital stroke triage, Emergency medical services, Stroke screening tools, Large vessel occlusion, Field assessment*

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1. INTRODUCTION:

1.1. The Burden of Stroke and the "Time Is Brain" Paradigm

Stroke remains a leading cause of death and long-term disability worldwide, imposing a substantial clinical and socioeconomic burden on individuals and healthcare systems (Feigin et al., 2017; Roth et al., 2020). Its burden is particularly increasing in low- and middle-income countries, emphasizing the need for efficient systems that facilitate early recognition and treatment (Donkor, 2018).

The principle of "time is brain" reflects the rapid progression of neuronal injury following acute ischemic stroke (Saver, 2006). Intravenous thrombolysis is most effective when administered promptly within the appropriate therapeutic window, while endovascular thrombectomy (EVT) has substantially improved outcomes for selected patients with large vessel occlusion (LVO), including those treated up to 24 hours after symptom onset (Goyal et al., 2015; Nogueira et al., 2018). Consequently, minimizing prehospital and in-hospital delays is fundamental to achieving favorable outcomes.

The stroke care pathway depends on a sequence of time-sensitive actions, including symptom recognition, EMS activation, rapid transport, hospital notification, diagnosis, and treatment. EMS transport and prehospital notification can reduce treatment delays and facilitate earlier stroke-team activation (Prabhakaran et al., 2013; McKinney et al., 2013). However, approximately one-third of ischemic strokes involve LVO, and presentations may be subtle or atypical, particularly in posterior circulation stroke, making systematic prehospital screening essential (Merwick & Werring, 2014).

1.2. The Prehospital Phase: The First Critical Link

EMS personnel are often the first healthcare professionals to evaluate patients with suspected stroke. Their responsibilities include initial recognition, neurological assessment, communication with receiving hospitals, and selection of an appropriate destination (Puolakka et al., 2016; Pride et al., 2017). Effective EMS assessment and prenotification can improve diagnostic pathways and reduce delays to reperfusion therapy (Prabhakaran et al., 2013; McKinney et al., 2013).

Prehospital stroke assessment occurs under significant time and resource constraints, often without access to neuroimaging, laboratory testing, or specialist consultation (Drenck et al., 2019). Variability in provider experience and the presence of stroke mimics may contribute to both under-triage and over-triage (Frendl et al., 2009; Oostema et al., 2019). These challenges highlight the need for screening tools that are rapid, simple, reliable, and sufficiently accurate for field use.

Early identification and hospital prenotification can accelerate imaging and treatment, particularly for patients eligible for reperfusion therapy (McKinney et al., 2013). For suspected LVO, accurate prehospital assessment is also important for determining whether patients should be transported directly to a comprehensive stroke center (CSC) or initially to a primary stroke center (PSC). This makes reliable field screening an essential component of contemporary stroke systems.

1.3. From Recognition to Triage: The Need for Standardized Screening

Public approaches such as FAST have improved recognition of common stroke symptoms and encouraged EMS activation (Wall et al., 2008). However, symptom recognition alone may fail to identify atypical presentations. The Cincinnati Prehospital Stroke Scale (CPSS) subsequently provided a structured assessment based on facial weakness, arm drift, and speech abnormalities (Kothari et al., 1997). With the development of EVT, newer tools such as RACE, LAMS, and FAST-ED have increasingly focused on identifying severe stroke and suspected LVO (Perez de la Ossa et al., 2014).

Prehospital screening has two principal objectives: identifying patients with suspected stroke and estimating stroke severity or LVO probability to guide destination decisions. Screening tools must therefore balance sensitivity, which reduces missed strokes, with specificity, which limits unnecessary transport and resource utilization. Stroke mimics—including hypoglycemia, seizure, migraine, and syncope—may complicate this balance (Hand et al., 2006; Nor et al., 2005).

The effectiveness of EVT for LVO has transformed prehospital triage by raising the question of whether patients with suspected LVO should bypass a nearer PSC and proceed directly to a CSC. Tools such as RACE, LAMS, FAST-ED, and C-STAT/C-PSSS incorporate additional neurological findings associated with LVO (Perez de la Ossa et al., 2014; Noorian et al., 2018; Lima et al., 2016; Katz et al., 2015). Nevertheless, their performance varies across populations, and limitations remain, particularly in detecting posterior circulation LVO and determining the optimal transport strategy (Zhelev et al., 2019).

1.4. Objectives and Scope of the Review
This review aims to comparatively evaluate widely used and validated prehospital stroke screening tools for the early identification of acute stroke. It focuses on their diagnostic performance, ability to identify LVO, clinical utility, ease of implementation, and potential role in prehospital destination decisions. By synthesizing the available evidence, the review seeks to clarify the strengths and limitations of these tools and identify their most appropriate applications within contemporary EMS stroke pathways.

2. METHODS:
2.1. Literature Search Strategy
A systematic search of PubMed/MEDLINE, Scopus, Web of Science, and the Cochrane Library was conducted from inception through December 2024. MeSH and free-text terms related to the prehospital setting, stroke, screening, and triage were combined with the names of relevant tools, including FAST, CPSS, LAPSS, MASS, ROSIER, RACE, FAST-ED, and C-PSSS. Reference lists of included studies and relevant reviews were also screened.

2.2. Eligibility Criteria
2.2.1. Inclusion Criteria
Studies were included if they were original research involving adults (≥18 years) with suspected acute stroke assessed by EMS personnel, evaluated at least one prehospital stroke screening tool, reported diagnostic accuracy or clinical utility outcomes, and were published in English.

2.2.2. Exclusion Criteria
Studies were excluded if they focused exclusively on in-hospital assessment, pediatric populations, or isolated TIA; assessed only layperson or dispatcher recognition; were case reports, editorials, commentaries, or conference abstracts; or lacked quantitative outcome data.

2.3. Study Selection and Data Extraction
Two reviewers independently screened titles, abstracts, and full texts, with disagreements resolved by consensus or a third reviewer. Data extracted included study characteristics, participant demographics, screening tools, reference standards, diagnostic accuracy measures (sensitivity, specificity, PPV, NPV, and AUC), and clinical implementation outcomes.

2.4. Data Synthesis and Analysis
Due to expected heterogeneity, findings were primarily synthesized narratively and descriptively. Tools were classified as simple recognition tools (CPSS, FAST), comprehensive tools (LAPSS, MASS, ROSIER), or LVO-specific tools (RACE, FAST-ED, C-PSSS). Diagnostic findings were summarized using reported ranges and median values where appropriate. Meta-analysis was considered when sufficient methodological and clinical homogeneity existed.

2.5. Quality and Risk of Bias Assessment
Risk of bias was independently assessed using QUADAS-2 for diagnostic accuracy studies and the Newcastle–Ottawa Scale for observational studies. Assessments informed interpretation but were not used as the sole basis for study exclusion.

2.6. Outcome Measures
2.6.1. Primary Outcomes
Primary outcomes were sensitivity, specificity, PPV, NPV, and AUC.

2.6.2. Secondary Outcomes
Secondary outcomes included inter-rater reliability, administration time, prehospital workflow, triage accuracy, treatment-related outcomes, and implementation feasibility.

2.7. Methodological Considerations
Potential sources of heterogeneity and bias included differences in populations, reference standards, EMS systems, screening thresholds, and evolving stroke-care practices, as well as potential publication bias and the English-language restriction.

2.8. Ethical Considerations
As this review analyzed previously published data without primary participant involvement, institutional ethical approval was not required.

3. RESULTS:

3.1. Overview of the Literature

The literature demonstrates substantial and increasing interest in prehospital stroke screening, with studies from North America, Europe, Australia, and Asia using prospective, retrospective, and diagnostic-accuracy designs. The tools can be broadly classified as: (1) simple recognition tools, including CPSS and FAST; (2) comprehensive tools, including LAPSS, MASS, and ROSIER; and (3) LVO-specific tools, including RACE, FAST-ED, and C-PSSS. These instruments differ primarily in diagnostic accuracy, administration time, training requirements, and suitability for destination triage.

3.2. Characteristics of Prehospital Stroke Screening Tools

3.2.1. Simple Recognition Tools: CPSS and FAST

CPSS and FAST are the most widely used prehospital stroke screening tools. Both assess facial weakness, arm weakness, and speech disturbance, while FAST adds a "Time" component to emphasize treatment urgency. Their main advantages are rapid administration, minimal training requirements, and high feasibility in routine EMS practice. Reported sensitivity generally ranges from 67–93%, with specificity of approximately 58–95% across studies (English et al., 2018).

3.2.2. Comprehensive Tools: LAPSS, MASS, and ROSIER

LAPSS, MASS, and ROSIER incorporate additional clinical information to improve specificity and identify common stroke mimics. LAPSS includes age, seizure history, symptom duration, glucose measurement, and motor assessment, whereas MASS and ROSIER incorporate additional neurological and mimic-exclusion criteria. These tools generally demonstrate higher specificity than CPSS and FAST but require more training and administration time. Their reported sensitivity is approximately 65–92%, with specificity ranging from 75–98% (Zhelev et al., 2019).

3.2.3. LVO-Specific Tools: RACE, FAST-ED, and C-PSSS

RACE, FAST-ED, and C-PSSS were developed to identify patients with suspected large vessel occlusion who may benefit from direct transport to comprehensive stroke centers. These tools incorporate cortical signs such as gaze deviation, aphasia, and neglect in addition to motor deficits. Their administration generally requires 2–4 minutes, with good diagnostic performance for LVO. RACE has received particularly extensive external validation (Dickson et al., 2019).

3.3. Comparative Diagnostic Performance

3.3.1. Sensitivity and Specificity

The literature demonstrates a consistent sensitivity–specificity trade-off. CPSS and FAST generally provide higher sensitivity and rapid recognition but lower specificity, whereas LAPSS and MASS improve specificity at the cost of potentially missing some strokes. RACE, FAST-ED, and C-PSSS provide a more targeted approach for LVO identification, with reported sensitivity and specificity generally within the 70–90% range (Dickson et al., 2019).

3.3.2. Predictive Values

Predictive values vary according to stroke prevalence and patient population. Higher-specificity tools such as LAPSS generally produce higher positive predictive values, whereas highly sensitive tools such as FAST provide stronger reassurance when the result is negative. Consequently, tool selection should reflect whether the primary objective is maximizing stroke recognition, reducing over-triage, or identifying patients suitable for advanced stroke-center transport.

3.3.3. Anterior versus Posterior Circulation Strokes

A major limitation across prehospital screening tools is reduced sensitivity for posterior circulation stroke. Symptoms such as isolated dizziness, vertigo, ataxia, visual disturbance, and dysarthria may occur without the facial, arm, or speech abnormalities emphasized by conventional tools. Posterior circulation stroke therefore remains an important source of prehospital under-recognition (Oostema et al., 2019).

3.4. Performance for Large Vessel Occlusion Detection

3.4.1. LVO-Specific Tool Performance

LVO-specific instruments generally outperform conventional stroke-recognition tools for identifying LVO. RACE, FAST-ED, and C-PSSS demonstrate good discriminatory ability, with reported AUC values generally around 0.80–0.90. RACE has been particularly well validated across independent cohorts and remains one of the most established tools for prehospital LVO triage (Dickson et al., 2019).

3.4.2. Comparison with Non-Specific Tools

CPSS and FAST are less effective for LVO identification because they primarily assess facial, arm, and speech deficits and do not adequately capture cortical signs. LVO-specific tools improve detection by incorporating gaze deviation, aphasia, neglect, and other indicators of severe anterior circulation stroke.

3.4.3. Posterior Circulation LVO

Despite their advantages for anterior circulation LVO, existing severity scales have limited sensitivity for posterior circulation LVO. This represents an important gap because posterior circulation occlusions may also require urgent endovascular treatment. Additional assessment of balance, coordination, eye movements, and visual deficits may improve detection (Oostema et al., 2019).

3.5. Stroke Mimics and Screening Errors

3.5.1. Prevalence and Types of Stroke Mimics

Stroke mimics represent a substantial proportion of patients assessed in the prehospital setting, with reported prevalence generally ranging from 10–35%. Common mimics include hypoglycemia, seizures, migraine, syncope, and metabolic or toxic conditions. Comprehensive tools that incorporate glucose measurement and seizure history tend to reduce false-positive identification compared with simpler recognition scales (Kim et al., 2019).

3.5.2. False Positive and False Negative Rates

Simple tools such as CPSS and FAST tend to produce more false positives because of their lower specificity, whereas comprehensive tools may produce more false negatives because of lower sensitivity. LVO-specific tools provide a compromise between sensitivity and specificity but remain imperfect. The clinical consequences of under-triage are generally more serious because missed stroke may delay reperfusion treatment.

3.5.3. Clinical Consequences of Screening Errors

False-negative results may delay diagnosis, reperfusion therapy, and appropriate destination selection, whereas false-positive results increase unnecessary transport and resource utilization. Because stroke treatment is highly time dependent, minimizing clinically significant under-triage remains a central objective of prehospital screening (Oostema et al., 2019).

3.6. Clinical and Operational Utility

3.6.1. Prehospital Notification and Hospital Activation

Implementation of standardized stroke screening protocols improves prehospital recognition and hospital notification. Screening tools facilitate structured communication between EMS personnel and receiving hospitals, allowing stroke teams, imaging services, and treatment pathways to be activated before patient arrival (Khor et al., 2015).

3.6.2. Door-to-Needle Time

Prehospital notification is associated with shorter door-to-needle times for thrombolysis. Reported reductions are generally in the range of 15–30 minutes, particularly when screening is integrated with hospital stroke activation protocols. These reductions are clinically important because earlier reperfusion is associated with better functional outcomes (Khor et al., 2015).

3.6.3. Thrombolysis Rates

Screening protocols have also been associated with increased thrombolysis rates, particularly when EMS identification is linked directly to hospital notification and stroke-team activation. The improvement appears to result from earlier recognition and more efficient in-hospital preparation rather than from the screening tool alone.

3.6.4. Administration Time and Feasibility

Administration time varies according to complexity. CPSS and FAST generally require 1–2 minutes, whereas more comprehensive or LVO-specific tools require approximately 2–5 minutes. Despite the additional assessment time, studies suggest that structured screening does not necessarily produce substantial increases in overall on-scene time (Drenck et al., 2019). Simpler tools are generally perceived as more feasible because of their minimal training requirements.

3.7. Prehospital Destination and Triage

3.7.1. Triage Accuracy and Transport Decisions

LVO-specific screening tools can improve identification of patients who may benefit from direct transport to comprehensive stroke centers. RACE and FAST-ED generally demonstrate better destination-triage performance than non-specific stroke scales and may reduce delays to endovascular thrombectomy when integrated into regional stroke systems (Jayaraman et al., 2020).

3.7.2. Over-Triage and Under-Triage

The choice of screening threshold influences the balance between over-triage and under-triage. Lower thresholds increase sensitivity but may increase unnecessary CSC transport, whereas higher thresholds improve specificity but risk missing patients with LVO. Therefore, the optimal threshold depends on local transport times, stroke-center availability, and the consequences of misclassification.

3.7.3. Regional System Integration

The effectiveness of prehospital screening is strongly influenced by integration with regional stroke systems. Destination decisions should consider screening results together with transport time, hospital capabilities, and access to thrombectomy. Recent trials, including RACECAT and the Stockholm Stroke Triage Study, have further highlighted the complexity of selecting the optimal prehospital destination strategy (Mazya et al., 2020).

4. DISCUSSION:

4.1. Principal Findings

This comparative review demonstrates that no single prehospital stroke screening tool is optimal for all clinical and operational purposes. The findings indicate a clear distinction between simple recognition tools, comprehensive screening instruments, and LVO-specific scales. CPSS and FAST offer rapid and feasible stroke recognition, whereas LAPSS, MASS, and ROSIER provide greater specificity through additional assessment of stroke mimics. RACE, FAST-ED, and C-PSSS are more appropriate when the primary objective is identifying suspected LVO and supporting destination decisions.

The most important limitation across the available tools is their reduced ability to detect posterior circulation stroke. In addition, the trade-off between sensitivity and specificity means that improving stroke recognition may increase over-triage, whereas greater specificity may increase the risk of missed strokes. These findings indicate that tool selection should be determined by the objectives, resources, transport geography, and organizational structure of the local EMS system rather than by diagnostic accuracy alone.

The review also indicates that screening tools can improve prehospital workflow by facilitating early hospital notification and potentially reducing treatment delays. Thus, their value extends beyond diagnostic classification to communication, hospital preparedness, and destination planning.

4.2. Diagnostic Performance and Clinical Interpretation

4.2.1. Sensitivity–Specificity Trade-off

The observed sensitivity–specificity trade-off is central to interpreting the comparative performance of screening tools. CPSS and FAST prioritize rapid recognition and are therefore particularly suitable when the principal concern is avoiding missed stroke. Their lower specificity, however, may result in more false-positive assessments and unnecessary stroke-center referrals. More comprehensive tools can reduce false positives but require additional assessment and may miss some patients with atypical presentations (Zhelev et al., 2019).

This trade-off should not be interpreted as evidence that one category is universally superior. Rather, it reflects different clinical priorities. In systems with short transport times and adequate stroke-center capacity, maximizing sensitivity may be preferable. Conversely, systems with substantial travel distances, limited comprehensive stroke centers, or constrained resources may require more specific triage strategies.

4.2.2. Predictive Values and Clinical Decision-Making

Predictive values further demonstrate why screening performance cannot be interpreted independently of the clinical setting. The prevalence of stroke and LVO varies between EMS populations, affecting the probability that a positive or negative screening result represents the true clinical condition. Consequently, screening results should support rather than replace clinical judgment.

Because the consequences of a missed stroke can be considerably greater than those of an unnecessary stroke evaluation, prehospital protocols should generally prioritize minimizing clinically important false negatives while maintaining acceptable levels of over-triage.

4.3. LVO Detection and Prehospital Triage

4.3.1. Role of LVO-Specific Tools

The increasing availability of EVT has shifted prehospital stroke assessment from simple stroke recognition toward identification of patients who may require advanced stroke-center care. The findings support the role of RACE, FAST-ED, and C-PSSS as useful tools for this purpose. Their inclusion of cortical signs provides information that is not adequately captured by CPSS and FAST and improves identification of patients with severe anterior circulation stroke (Dickson et al., 2019).
However, these tools should be viewed as triage instruments rather than definitive diagnostic tests. A positive LVO screen does not establish vessel occlusion, and a negative result cannot reliably exclude LVO, particularly in patients with atypical or posterior circulation presentations.

4.3.2. Destination Decisions and Time-to-Treatment

The Results indicate that LVO-specific screening can improve destination decisions and potentially reduce time to EVT. The clinical importance of this finding is substantial because unnecessary interhospital transfer can introduce additional delays in patients who require thrombectomy. Nevertheless, direct transport to a comprehensive stroke center may also increase transport time for patients who ultimately do not have LVO.

Therefore, the appropriate destination strategy should incorporate both the screening result and system-level factors, including the additional travel time to a comprehensive center, availability of thrombectomy, and the capacity of primary and comprehensive stroke centers. This supports a context-dependent rather than universal approach to LVO triage.

4.4. Clinical Utility and Implementation

4.4.1. Prehospital Workflow

The association between screening-tool implementation, improved hospital notification, and shorter treatment times suggests that the principal benefit of these tools may extend beyond their diagnostic accuracy. A standardized assessment provides EMS personnel with a common language for communicating neurological findings and allows receiving hospitals to prepare before patient arrival (Khor et al., 2015).

Importantly, the additional time required for more comprehensive tools does not appear to substantially increase overall on-scene time. This suggests that appropriately designed screening protocols can be incorporated into routine EMS practice without compromising operational efficiency.

4.4.2. Feasibility and Training

Feasibility remains an important determinant of successful implementation. Simpler tools are easier to teach, remember, and apply under time pressure, whereas more complex instruments may provide additional clinical information at the cost of greater training requirements. This is particularly relevant in EMS systems with limited educational resources or frequent staff turnover.

Accordingly, implementation should include standardized training, practical simulation, periodic competency assessment, and quality monitoring. Diagnostic accuracy demonstrated under research conditions may not be reproduced in routine practice unless providers are adequately trained and protocols are consistently applied.

4.5. Implications for Prehospital Stroke Systems

The findings support a **stratified approach** to prehospital stroke assessment. CPSS or FAST may be appropriate for initial stroke recognition because of their simplicity and speed. A subsequent assessment using an LVO-specific scale can then support destination decisions where thrombectomy services are available. Comprehensive tools may be particularly useful when exclusion of common stroke mimics is a major priority.

Integration with hospital systems is equally important. Screening tools are most effective when their results trigger standardized prehospital notification, stroke-team activation, and destination protocols. Thus, improving stroke outcomes requires not only selecting an appropriate screening instrument but also embedding it within an integrated regional stroke pathway.

4.6. Posterior Circulation Stroke and Evidence Gaps

The poor detection of posterior circulation stroke represents the most important unresolved limitation identified in this review. Conventional screening tools emphasize facial weakness, arm weakness, speech disturbance, and other signs that may be absent in posterior circulation stroke. Consequently, patients presenting primarily with dizziness, imbalance, visual symptoms, ataxia, or dysarthria may be overlooked (Oostema et al., 2019).

This limitation has important implications for both stroke recognition and LVO triage. Future tools should incorporate clinical features that better represent posterior circulation disease, potentially including balance, coordination, ocular findings, and visual abnormalities. However, such modifications must be evaluated prospectively to determine whether increased sensitivity can be achieved without unacceptable reductions in specificity.

Other important evidence gaps include the limited number of direct head-to-head comparisons, substantial heterogeneity between study populations, and variation in EMS systems and destination protocols. Future research should therefore prioritize prospective comparative studies conducted within clearly defined regional stroke systems.

4.7. Implications for Clinical Practice and Future Research

The findings suggest that prehospital stroke screening should be goal-oriented rather than tool-oriented. EMS systems should first define their principal objective and then select the instrument that best meets that objective.

Local validation is particularly important because performance may change according to population characteristics, stroke prevalence, EMS training, transport distances, and hospital availability. Future research should also evaluate telemedicine, mobile stroke units, artificial intelligence, and other technologies that may complement conventional bedside screening.

Rather than replacing established tools immediately, emerging technologies should be evaluated according to whether they improve sensitivity for difficult presentations, reduce unnecessary transfers, shorten treatment times, and remain feasible under real-world prehospital conditions.

4.8. Proposed Prehospital Stroke Triage Framework

Based on the findings, a practical framework can be conceptualized as a **tiered process**:

1. Use CPSS or FAST to rapidly identify suspected stroke and initiate prehospital notification.
2. Apply an LVO-specific tool such as RACE, FAST-ED, or C-PSSS when appropriate;

use additional assessment for suspected stroke mimics.
3. Combine the screening result with transport time, stroke-center capability, and local EVT pathways.
4. Maintain a low threshold for further assessment in patients with symptoms suggestive of posterior circulation stroke despite a negative conventional screen.
5. Continuously monitor sensitivity, specificity, over-triage, under-triage, treatment times, and patient outcomes to validate and refine the selected protocol.

Overall, the evidence supports a flexible, integrated, and locally validated approach rather than universal adoption of a single screening instrument. The optimal prehospital stroke pathway is one that balances diagnostic accuracy with feasibility, transport logistics, resource availability, and the time-sensitive nature of reperfusion therapy.

5. Future Research Directions

Based on the findings of this review, future research should focus on the following priorities:

1. Conduct head-to-head prospective studies comparing major prehospital stroke screening tools within the same EMS populations and settings, evaluating diagnostic accuracy, feasibility, triage decisions, treatment times, and patient outcomes.
2. Refine existing LVO-specific tools and develop new approaches with greater sensitivity, particularly for posterior circulation LVO and atypical presentations.
3. Develop and validate screening approaches incorporating signs such as ataxia, dysarthria, visual disturbances, and ocular abnormalities, which are poorly captured by conventional tools (Oostema et al., 2019).
4. Evaluate telemedicine, mobile stroke units, portable neuroimaging, point-of-care technologies, and artificial intelligence as complementary approaches to improve prehospital diagnosis and triage.
5. Investigate barriers and facilitators to the adoption of screening tools, including training, provider competency, protocol design, hospital integration, and regional stroke-system characteristics.
6. Conduct health-economic evaluations comparing screening and triage strategies, considering training costs, transport, over-triage, under-triage, treatment delays, and patient outcomes.
7. Validate screening tools within different populations and healthcare systems, particularly resource-limited settings, to determine whether their reported diagnostic performance is transferable to local EMS conditions.
8.

6. Contributions and Limitations of the Study

6.1. Contributions of the Study

The main contributions of this review are:

1. Provides a comparative synthesis of major prehospital stroke screening tools, including CPSS, FAST, LAPSS, MASS, ROSIER, RACE, FAST-ED, and C-PSSS.
2. Examine tools not only in terms of sensitivity and specificity but also clinical utility, feasibility, implementation, hospital notification, treatment times, and destination triage.
3. Incorporates LVO-specific screening tools and examines their role in identifying patients who may benefit from direct transport to comprehensive stroke centers.
4. Highlights the consistently lower performance of existing screening tools for posterior circulation stroke as an important unresolved clinical problem.
5. Provides evidence-based considerations for selecting screening tools according to EMS objectives, available resources, transport characteristics, and stroke-system organization.
6.

6.2. Limitations of the Study

The main limitations of this review are:

1. Differences in study design, populations, EMS systems, reference standards, and outcome definitions limit direct comparison of diagnostic performance.
2. The literature may be affected by preferential publication of positive findings, while restricting the review to English-language studies may have excluded relevant evidence.
3. Differences in methods used to confirm stroke diagnosis may have contributed to variability in reported sensitivity and specificity.
4. Some included studies were conducted before the widespread adoption of EVT and may therefore have limited relevance to current LVO triage strategies.
5. Due to substantial methodological and clinical heterogeneity, pooled estimates were not calculated, limiting the ability to provide definitive comparative effect estimates.
6. Reported performance may not be directly transferable to all EMS and healthcare settings, particularly resource-limited systems with different training, transport, and stroke-center infrastructure.

7. CONCLUSIONS:

This review evaluated major prehospital stroke screening tools. No single tool is optimal for all settings. Simpler tools (CPSS, FAST) offer high sensitivity (78-85%) but lower specificity (76-82%). Comprehensive tools (LAPSS, MASS) offer higher specificity (88-94%) but lower sensitivity (75-86%). LVO-specific tools (RACE, FAST-ED, C-PSSS) offer balanced performance (78-82% sensitivity, 82-84% specificity) (Lima et al., 2016).

All tools have lower sensitivity for posterior circulation strokes (45-60%) versus anterior (75-90%) (Merwick & Werring, 2014). Screening tool use improves notification rates (40-60% to 70-90%), reduces door-to-needle time (15-30 minutes), and increases thrombolysis rates (10-25%) (McKinney et al., 2013). LVO-specific tools enable accurate transport decisions (75-85%) and reduce time-to-EVT by 45-60 minutes (Jayaraman et al., 2020).

Tool selection should consider stroke prevalence, transport times, hospital capabilities, and EMS training (Zhelev et al., 2019). A tiered approach may be optimal. Future research should focus on comparative studies, posterior stroke detection, and technology integration (Abedi et al., 2017).

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