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Review Of Paramedics' Role In Stroke Identification And Prehospital Stroke Care

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Abstract

Stroke is a leading cause of death and disability worldwide, and early identification and prehospital care by paramedics are crucial for improving patient outcomes. This review examines the role of paramedics in stroke identification and prehospital care, focusing on the tools and protocols used, training and education, challenges and limitations, and recent innovations. Paramedics use validated screening tools such as FAST, CPSS, LAPSS, and RACE to rapidly identify stroke symptoms in the field. Training programs, particularly interactive, scenario-based sessions, significantly improve paramedics' accuracy in stroke recognition and reduce transport times to hospitals. However, challenges remain, including stroke mimics, limitations in screening tool sensitivity and specificity, insufficient training, and disparities between urban and rural EMS resources. Recent advances, such as mobile stroke units, telemedicine-enabled ambulances, and AI-powered diagnostic aids, show promise in enhancing prehospital stroke care. Recommendations for improvement include enhanced and tailored education, regular feedback mechanisms, standardized evidence-based protocols, technological integration, and system-level collaboration between EMS and hospital teams. By empowering paramedics with the necessary knowledge, tools, and support, prehospital stroke care can be optimized, leading to improved patient survival, functional recovery, and reduced societal and economic burden of stroke.

Keywords: Stroke, EMC, Paramedical, Prehospital Stroke Care.

Introduction

Stroke remains one of the most significant causes of death and disability worldwide, representing a critical public health challenge. It is the second-leading cause of mortality and the third-leading cause of combined death and disability globally, with projections estimating a continual increase in stroke incidence over the coming decades. Stroke results from the sudden disruption of blood flow to the brain, either due to ischemia caused by an arterial blockage or hemorrhage due to vessel rupture. This disruption leads to rapid brain cell death and can result in permanent neurological damage or death if not addressed promptly (Melaika et al., 2022).

The critical element in improving stroke outcomes lies in the early identification of stroke symptoms and rapid initiation of care. Time is brain; every minute delay in treatment results in the loss of millions of neurons, reducing the chances of functional recovery. Timely recognition and management significantly improve the efficacy of acute treatments such as thrombolysis and mechanical thrombectomy, which are most effective when administered within a narrow therapeutic window after symptom onset. Therefore, the prehospital phase—the time from symptom onset until hospital arrival—represents a crucial period during which prompt detection and expedited care can profoundly impact morbidity and mortality (Pierotti, 2024).

Premised on this urgency, prehospital stroke care aims to minimize delays in diagnosis and transport, ensuring patients receive definitive treatment as quickly as possible. Early recognition can reduce long-term disability and improve survival by enabling rapid transport to specialized stroke centers equipped for advanced interventions. Moreover, effective prehospital care involves the use of validated stroke screening tools and communication protocols that facilitate hospital prenotification and preparedness, optimizing the entire stroke care pathway (Zachrison et al., 2023a).

Early recognition of stroke symptoms followed by rapid prehospital care is crucial, as timely treatment can significantly reduce brain injury and improve functional outcomes. The phrase "time is brain" underscores that every minute of delayed treatment leads to neuronal loss, impacting recovery chances. Prehospital care aims to minimize delays by enabling early detection, prompt EMS activation, and rapid transport to specialized stroke centers for acute interventions such as intravenous thrombolysis or mechanical thrombectomy (Zachrison et al., 2023b).

The therapeutic window for effective ischemic stroke treatment is narrow, with intravenous thrombolysis approved up to 4.5 hours and mechanical thrombectomy up to 6 hours after symptom onset in many cases, though earlier treatment is always preferred. Delays in hospital arrival substantially reduce eligibility for these interventions, highlighting the necessity of efficient prehospital pathways (Wu et al., 2024a).

Rationale for Focusing on Paramedics' Role

Paramedics and emergency medical services (EMS) personnel are often the first healthcare providers to encounter stroke patients and play a pivotal role in the entire stroke care continuum. Approximately two-thirds of stroke patients make contact with the healthcare system via EMS, highlighting the preeminent position paramedics hold in the initial stroke response. Their ability to accurately identify stroke symptoms, differentiate true strokes from mimics, and initiate rapid transport to appropriate facilities directly influences patient outcomes (Melaika et al., 2022).

However, challenges remain. Studies have shown that EMS professionals may fail to identify up to one-third of stroke cases, and there is often variability in stroke knowledge, training, and feedback across different EMS settings. Paramedics' ability to perform reliable stroke assessments using validated tools and to communicate effectively with receiving hospitals is essential to reducing prehospital delays and ensuring that patients benefit from timely therapies.

Given these factors, a focused review on paramedics' role in stroke identification and prehospital care is warranted. Understanding current practices, knowledge gaps, training needs, and operational challenges can inform targeted interventions that enhance paramedic performance, leading to improved stroke care delivery and patient prognosis.

Objectives and Scope of the Review

This review aims to comprehensively examine the role of paramedics in stroke identification and prehospital care. The specific objectives are:

- To provide a detailed overview of the clinical importance of early stroke recognition and the impact of prehospital care on patient outcomes.
- To evaluate the methods and tools used by paramedics for stroke identification, including their accuracy, limitations, and training requirements.
- To analyze current models of prehospital stroke care, including stroke screening protocols, prenotification systems, and transport logistics.
- To identify barriers faced by paramedics in stroke care delivery and propose evidence-based recommendations to optimize their role.
- To highlight future directions for research and training to enhance paramedic stroke care capabilities.

The review will encompass literature from recent clinical studies, guidelines, and EMS practice reports to present an integrated picture of the current state and future potential of paramedics' contributions to acute stroke management.

Stroke Identification by Paramedics: Tools and Protocols

Paramedics utilize structured screening tools to rapidly identify stroke symptoms in the prehospital setting. One widely validated tool is the Los Angeles Prehospital Stroke Screen (LAPSS), which is specifically designed for ambulance personnel to detect stroke within minutes. LAPSS includes assessment of history items, blood glucose measurement, and unilateral motor weakness evaluation. Its application has demonstrated high sensitivity and specificity in field validation studies, enabling paramedics to discriminate acute stroke from mimics efficiently. Other tools such as the Cincinnati Prehospital Stroke Scale (CPSS), and more recently modified Rapid Arterial oCclusion Evaluation (mRACE) scale, provide alternatives tailored for different EMS systems, though sensitivity and specificity can vary, impacting diagnostic accuracy. EMS regions often adopt a standardized screening protocol to ensure consistent stroke recognition and reduce prehospital delays (Chen et al., 2013; Pourahmad et al., 2022; Rahangdale et al., 2019).

Prehospital Stroke Care Interventions

Once a stroke is suspected, paramedics perform critical assessments and interventions on scene and during transport to optimize outcomes. These include:

- Neurological assessment focusing on stroke signs using validated scales.
- Vital signs monitoring including blood pressure, heart rate, and oxygen saturation.
- Blood glucose measurement to exclude hypoglycemia, a common stroke mimic.
- Rapid communication with receiving stroke centers to enable prenotification and prepare acute treatments.
- In some systems, administration of early therapies or expedited transport protocols are implemented to decrease time to reperfusion treatment (Zachrison et al., 2023a).

Timely and accurate assessment is essential in facilitating rapid triage to stroke-ready hospitals, thereby improving reperfusion therapy rates and patient survival.

Paramedics' Role in Stroke Identification

Paramedics are trained to identify key stroke indicators including sudden unilateral weakness or numbness, facial droop, speech disturbances such as aphasia or dysarthria, and sudden vision problems or dizziness. Prompt recognition of these signs in the field is critical to initiate early stroke care (Wu et al., 2024b).

Overview and Comparison of Stroke Identification Tools Used by Paramedics

Several validated stroke screening tools assist paramedics in rapid assessment:

- FAST (Face, Arm, Speech, Time): Simple mnemonic assessing facial droop, arm weakness, and speech abnormalities.
- Cincinnati Prehospital Stroke Scale (CPSS): Evaluates facial droop, arm drift, and speech impairment with reported sensitivity around 93%.
- Los Angeles Prehospital Stroke Screen (LAPSS): Includes history, blood glucose check, and unilateral motor weakness; has high sensitivity and specificity.
- Mobile Stroke Scale (MASS) and mNIHSS (modified National Institutes of Health Stroke Scale): More detailed scales used in some EMS systems for severity grading.
- RACE (Rapid Arterial oCclusion Evaluation) scale: Focuses on detecting large vessel occlusions with reasonable sensitivity and specificity.

Training and Education of Paramedics

Educational programs for paramedics significantly enhance stroke recognition accuracy and prehospital care quality. Studies show that interactive, scenario-based training sessions improve paramedics' positive predictive value for stroke identification and reduce transport times to hospitals. Such programs increase confidence in managing suspected stroke and lower rates of misdiagnosis. However, there remain disparities in training needs between urban and suburban paramedic groups, with suburban providers often requiring more frequent and targeted education. Continuous professional development and feedback mechanisms from hospitals to paramedics reinforce learning and encourage adherence to updated protocols (Sveikata et al., 2022).

Challenges and Limitations

Several obstacles hinder optimal stroke identification and care in prehospital settings. These include:

- Stroke mimics such as vertigo, seizures, brain tumors, and hypoglycemia can lead to diagnostic errors, resulting in overtriage or inappropriate treatment.
- Limitations in the sensitivity and specificity of existing stroke scales create challenges in definitive field diagnosis .
- Barriers like insufficient training, high turnover of EMS personnel, and lack of feedback on patient outcomes impede quality improvement (Wolcott & English, 2024).
- Social and logistical factors, including variation in EMS resources between urban and rural areas, also affect timely stroke care delivery (Wells et al., 2024).

Collectively, these challenges necessitate ongoing efforts to refine assessment tools and support paramedic education.

Innovations and Advances

Recent advances have introduced novel technologies and protocols to enhance prehospital stroke care:

- Mobile Stroke Units (MSUs) equipped with imaging capabilities and telemedicine support, allow initiation of stroke treatment (e.g., thrombolysis) at the scene, reducing therapeutic delays significantly (English et al., 2022).

- Telemedicine-enabled ambulances or mini-MSU connect paramedics with vascular neurologists via real-time audiovisual links fostering expert guidance during prehospital care (Harahsheh et al., 2024).
- Emerging diagnostic aids powered by artificial intelligence, such as portable EEG, transcranial Doppler, and impedance spectroscopy headsets, promise improved discrimination of stroke subtypes including large vessel occlusion in prehospital settings.
- Enhanced prehospital protocols integrating severity scales and direct transport to comprehensive stroke centers optimize patient outcomes and resource utilization (Wells et al., 2024).

These technologies are poised to transform paramedic roles and stroke systems of care in the near future.

Discussion

Paramedics occupy a critical frontline position in the acute management of stroke due to their role as first healthcare responders, often being the initial point of patient contact. Their ability to rapidly recognize stroke symptoms and correctly triage patients directly affects time-sensitive treatments such as intravenous thrombolysis and mechanical thrombectomy, which have narrow therapeutic windows. Studies consistently demonstrate that paramedics' early stroke identification using validated tools like the Los Angeles Prehospital Stroke Screen (LAPSS), Cincinnati Prehospital Stroke Scale (CPSS), and the modified Rapid Arterial oCclusion Evaluation (mRACE) scale yields good sensitivity and specificity but remains imperfect, with up to one-third of strokes missed or misclassified in some settings .

Training interventions, particularly interactive, scenario-based stroke education sessions, significantly improve paramedics' positive predictive value for stroke recognition and reduce delays in hospital arrival, with associated trends toward improved patient survival. These findings affirm that continuous professional development is a powerful modifiable factor enhancing EMS stroke care quality. Furthermore, structured prehospital protocols including stroke screening, vital sign checks, blood glucose measurement, and pre-notification of stroke centers to optimize resource preparedness have become widely recommended best practices—as endorsed by professional bodies such as the American Heart Association (AHA) (Powers et al., 2019).

Despite these strengths, persistent challenges impede optimal prehospital stroke care. Diagnostic confusion with stroke mimics such as vertigo, seizures, or hypoglycemia leads to both undertriage and overtriage, taxing emergency resources and risking patient harm. Additionally, disparities exist between urban and suburban/rural EMS providers, with suburban paramedics often reporting less confidence, fewer training opportunities, and a higher need for education tailored to their contexts. The lack of formal, consistent feedback from hospitals on patient outcomes transported by paramedics further limits continuous learning and performance improvement in EMS systems. Data indicate that full compliance with comprehensive prehospital stroke care guidelines remains low nationwide, contributing to variability in care quality and patient outcomes (Dylla et al., 2024).

Emergent technologies such as Mobile Stroke Units (MSUs) equipped with onboard imaging and telemedicine capacity are proving efficacious in substantially reducing onset-to-treatment times and increasing reperfusion therapy rates, representing an exciting frontier in prehospital stroke care. However, these innovations require extensive infrastructure investments, optimal logistic integration with existing EMS networks, and comprehensive paramedic training to maximize impact (Navi et al., 2022).

Implications for Patient Outcomes and Healthcare System Efficiency

Time-criticality dominates the stroke treatment paradigm, and enhanced prehospital stroke identification and management unequivocally translate into better clinical outcomes. Prehospital stroke team activation and hospital prenotification reduce door-to-needle times and improve functional recovery at 90 days post-

stroke. Efficient EMS protocols and streamlined transport pathways directly increase the proportion of patients eligible for acute interventions, decreasing mortality and disability burden. By minimizing unnecessary emergency department evaluation delays through accurate field diagnosis and advanced prenotification, EMS systems contribute to hospital workflow optimization and higher throughput efficiency (Lodhi et al., 2025).

From the healthcare system perspective, improved paramedic stroke care capabilities reduce the economic and social costs of stroke by preventing long-term disability and reducing hospitalization lengths. Although advanced prehospital interventions and new technologies entail upfront expenditures, these investments may be offset by downstream savings from better patient outcomes and reduced rehabilitation needs. Closer integration and collaboration between EMS and hospital stroke teams foster resource sharing and coordinated stroke system development, enhancing overall care quality while avoiding duplication of efforts (Fladt et al., 2023).

Recommendations for Improving Paramedic Training, Protocols, and Research Directions

1. Enhanced and Tailored Education: Paramedic training should incorporate repeated, interactive, scenario-based stroke recognition modules with periodic refresher courses, emphasizing differentiation of stroke mimics. Training curricula must be adapted to address geographic disparities, particularly augmenting suburban and rural EMS capabilities.
2. Regular Feedback Mechanisms: Establishing formalized hospital-to-EMS feedback loops regarding stroke patient outcomes can promote reflective learning and continual performance enhancement for paramedics, encouraging adherence to best practice guidelines.
3. Standardized and Evidence-Based Protocols: Implementation and rigorous enforcement of validated stroke screening tools and prehospital care protocols should be universal, including mandatory documentation of stroke onset times, blood glucose checks, and vital signs monitoring. Protocols should include prompt hospital prenotification to enable timely activation of stroke teams.
4. Technological Integration: Wider deployment of Mobile Stroke Units and telemedicine support within EMS is recommended to enable early on-scene diagnosis and initiation of therapy, especially in rural and underserved areas. Investment decisions should be guided by cost-effectiveness analyses and infrastructure feasibility studies.
5. Research Priorities: Future research should focus on optimizing retraining intervals for paramedics, evaluating the long-term clinical and economic impacts of advanced prehospital interventions, refining stroke screening tools to improve sensitivity without excessive false positives, and exploring artificial intelligence applications for enhancing stroke diagnosis accuracy in the field.
6. System-level Collaboration: Development of integrated stroke systems of care involving EMS, emergency departments, neurology, and rehabilitation services is essential for seamless patient transitions and optimized resource utilization.

Conclusion

Paramedics play a pivotal role in the early recognition and management of stroke, serving as the essential link between patients and definitive hospital care. Their ability to rapidly identify stroke symptoms, initiate prehospital assessments, and ensure timely transport to specialized centers significantly improves access to life-saving therapies such as thrombolysis and mechanical thrombectomy. While validated screening tools and structured protocols have enhanced diagnostic accuracy, challenges such as stroke mimics, variability in training, and limited feedback mechanisms continue to hinder optimal outcomes. Emerging innovations—including mobile stroke units, telemedicine integration, and artificial intelligence—hold great

promise in augmenting prehospital stroke care, but their success depends on effective implementation, ongoing education, and system-level coordination. Strengthening paramedic training, standardizing evidence-based protocols, and fostering closer collaboration between EMS and hospital teams are critical steps toward optimizing stroke care pathways. Ultimately, empowering paramedics with the knowledge, tools, and support they need will not only improve patient survival and functional recovery but also reduce the long-term societal and economic burden of stroke.

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