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Opinion Article

Utility of Portable Neuroimaging Devices in Emergency Stroke Diagnosis

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DESCRIPTION

Stroke remains a leading cause of death and long-term disability worldwide. In high-income countries, the burden of stroke is compounded not only by its frequency but also by the high cost of delayed intervention. The phrase "time is brain" is more than a catchphrase it is a fundamental truth in stroke care. With each minute of delay, millions of neurons are lost, reducing the likelihood of functional recovery and increasing healthcare expenditures. Yet, even in well-resourced settings, delays in diagnosis and triage persist, especially in prehospital environments.

Traditional stroke imaging namely, non-contrast Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) requires fixed infrastructure, highly trained personnel and often centralized hospital-based services. These requirements pose a significant challenge in rural areas, during ambulance transit, or even in crowded urban emergency departments. In this context, portable neuroimaging devices have emerged as a revolutionary technology with the promising to transform emergency stroke care. Portable neuroimaging technologies, such as head-mounted EEG, microwave imaging and more recently, portable low-field MRI and portable CT scanners, are now being developed and deployed in experimental and limited clinical settings. These devices allow imaging to begin at the point of care whether that is in the ambulance, an urgent care clinic, or a remote hospital. This not only expedites diagnosis but also facilitates rapid triage decisions, such as determining eligibility for thrombolytic therapy or mechanical thrombectomy.

Perhaps one of the most promising devices is the portable stroke detection headband based on electromagnetic waves and machine learning algorithms. Clinical pilot studies have demonstrated that such devices can distinguish between ischemic and haemorrhagic strokes with moderate to high accuracy, well before a patient reaches the hospital. Similarly, portable low-field MRI systems, which do not require specialized shielding or fixed installations, are showing promise in bedside imaging of neurological conditions, including stroke. The benefits of these technologies are numerous. First, they significantly reduce diagnostic latency, which is important for time-sensitive therapies like tissue Plasminogen Activator (tPA). Second, they enable pre-hospital triage, allowing paramedics to bypass non-thrombectomy-capable centres when Large Vessel Occlusion (LVO) is suspected. Third, these devices can extend neuroimaging access to underserved or geographically isolated populations, helping to reduce disparities in stroke outcomes.

Moreover, portable neuroimaging could aid in stroke mimics differentiation conditions like seizures, migraines, or hypoglycaemia, which can present similarly to acute stroke. Accurate early distinction helps avoid unnecessary treatments, reduces emergency room crowding and allocates resources more efficiently. Despite these compelling advantages, several challenges hinder widespread adoption. Diagnostic accuracy is a major concern most portable devices are still in early phases of validation and do not yet match the resolution and reliability of conventional imaging. Regulatory bodies such as the FDA have yet to approve many of these devices for frontline clinical decision-making. Additionally, the cost-effectiveness of deploying portable neuroimaging on a large scale is still under debate, especially in systems where advanced ambulances and stroke teams are already available.

Another limitation is the interpretation of portable imaging data. Some devices rely on algorithmic outputs that may not be easily understood by first responders. Integrating real-time remote consultation *via* telemedicine could help bridge this gap, but adds another layer of complexity and promising delay. Importantly, we must ensure that the push for technological innovation does not replace clinical judgment but enhances it. Stroke diagnosis is multifactorial and no device should serve as the sole determinant in initiating high-risk therapies. Instead, portable neuroimaging should be viewed as an adjunct tool that supports timely and evidence-based clinical decisions.

CONCLUSION

The utility of portable neuroimaging devices in emergency stroke diagnosis is no longer a futuristic concept it is a present-day possibility with profound implications. These tools have the promising to drastically reduce treatment delays, expand access to expert care and improve stroke outcomes, particularly when deployed in prehospital or resource-limited settings. However, thoughtful integration into clinical workflows, strong validation

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and interdisciplinary collaboration are essential for these technologies to succeed. Regulators, clinicians, engineers and policymakers must work in concert to ensure safety, efficacy and accessibility. The path ahead is promising. With continued innovation, evidence generation, and stakeholder engagement, portable neuroimaging may become a standard component of stroke care bringing diagnosis to the patient, rather than waiting for the patient to reach the diagnosis. It is a shift that could save time, save costs and most importantly, save lives.