

TOPICAL REVIEW

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Integrating Digital Health Into Stroke Policies

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ABSTRACT: Stroke remains a leading cause of death and disability worldwide. In response, many governments have developed stroke policies emphasizing prevention, early detection, timely treatment, and rehabilitation. However, the implementation of those strategies remains uneven, challenged by fragmented health systems, unequal access to care, and resource constraints. Digital health tools provide robust solutions to enhance national and regional stroke policies by improving data collection, care access and coordination, monitoring, education, and public engagement. This review explores how digital health can strengthen stroke care systems across different contexts, highlighting real-world applications, policy integration, and strategic enablers for equitable implementation.

GRAPHIC ABSTRACT: A [graphic abstract](#) is available for this article.

Key Words: artificial intelligence ■ emergency medical services ■ digital health ■ policy ■ stroke



Stroke remains a leading cause of death and long-term disability,¹ imposing a disproportionate burden on low- and middle-income countries (LMICs). Organizing stroke systems of care into interconnected domains—community education, primordial and primary prevention, emergency medical services (EMS) response, acute stroke treatment, secondary prevention, and rehabilitation—is fundamental to optimize outcomes and reduce the global burden of stroke, requiring continuous system-wide monitoring. Fragmentation and gaps within any phase can compromise outcomes, leading to increased disability and escalating healthcare costs.^{2–4}

Despite the availability of evidence-based strategies throughout the stroke care continuum, major implementation gaps persist globally, particularly in LMICs but also in high-resource settings.^{5,6} Key challenges include limited public awareness, insufficient prevention programs, delays in hospital access, limited availability of acute interventions, insufficient rehabilitation services,^{7–10} compounded by workforce shortages and infrastructure limitations, including stroke units and neuroimaging.^{2–4,6,11} Geographic and socioeconomic disparities

worsen access inequities. Weak care pathways, limited workforce training, inadequate insurance coverage, and the absence of national stroke registries contribute to unaddressed needs, higher complication rates, preventable hospital readmissions, and hindered quality improvement.^{3–6,8,9}

Integrating digital health into stroke policies represents a transformative opportunity to address these gaps. Digital solutions can help health systems overcome geographic, economic, and workforce barriers—an especially relevant advantage for LMICs. Telemedicine and telerehabilitation expand access to specialist expertise in underserved areas,^{5,6,8,12} mobile health (mHealth) applications, and wearable devices support continuous remote monitoring, strengthening primary and secondary prevention efforts,¹⁰ digital stroke registries allow real-time data collection and early interventions to address care gaps, fostering quality improvement, resource optimization, and more precise epidemiological tracking.^{7,8,12,13} Complementarily, digital platforms can standardize care pathways, provide clinical decision support, and deliver tailored education to healthcare professionals and

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Supplemental Material is available at <https://www.ahajournals.org/doi/suppl/10.1161/STROKEAHA.125.050451>.

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patients, promoting adherence to protocols and empowering self-management.^{6,8,12}

This review synthesizes current evidence on the role of digital tools in enhancing stroke care systems, with an emphasis on practical applications, strategic benefits, and policy integration.

METHODS

A comprehensive literature search was conducted using OVID MEDLINE and EMBASE. The search strategy combined keywords and MeSH terms related to “stroke,” “digital health,” and “policy.” Search terms also included “automated algorithms,” “decision support platform,” “telemedicine,” “mobile applications,” “mHealth,” “digital applications,” and “artificial intelligence.”

The search was focused on articles published in English since 2015. Reference lists of key publications were manually reviewed, and policy documents from the World Health Organization, World Stroke Organization, American Stroke Association, and European Stroke Organization were examined. Articles were selected based on their relevance to digital health applications in stroke care, including their role in policy formulation, implementation, or system-level impact.

This review presents global case studies demonstrating how digital health can support and strengthen stroke care policies, highlighting its potential to address key challenges. A detailed overview of the search strategy is in the [Supplemental Material](#). Figures 2 and 4 were generated with artificial intelligence (AI) assistance (Manus AI platform) and verified by the authors.

PRIMARY CARE

Integrating digital health interventions into stroke policies in primary care is pivotal to improve access to care, enabling timely intervention, and promoting continuous patient engagement. When effectively implemented, these strategies reduce stroke incidence and improve patient outcomes through efficient, scalable, and patient-centered approaches. Key approaches are mentioned below.

Digital Health Interventions in Primary Care

In a Chinese cluster-randomized trial¹⁴ across 218 villages, a customized mHealth-enabled poststroke management program embedded in primary health care achieved sustained benefits, including a 4.5 mmHg reduction in systolic blood pressure (BP; 95% CI, 2.2–6.8) and a 27% lower risk of stroke recurrence at 4.5 years compared with usual care.

Electronic health records enriched with AI integrated into patient care can improve the quality of care by providing protocol-based guidance and alerts for uncontrolled risk factors.¹⁵ These systems support government oversight of population-level prevalence and control of risk factors. However, interventions focusing solely on patient education or behavior, without system-level support, are less effective.¹⁶

Evidence from systematic reviews and global policy analyses reinforces the value of digital health across multiple modalities, including mHealth applications, SMS-based interventions, telemedicine, Web-based platforms, and AI-assisted decision support. Collectively, these tools enhance risk assessment, improve BP control, encourage lifestyle modification, and promote adherence to secondary prevention strategies. Digital health-enabled polypill strategies provide a scalable, cost-effective approach to improve adherence and reduce recurrent strokes.¹⁷ Their demonstrated feasibility and effectiveness make them promising candidates for large-scale implementation in primary care networks, particularly in LMICs.^{14,18–20} Nevertheless, key challenges persist. Ensuring equitable digital access, safeguarding data privacy, and achieving seamless integration with existing health systems remain critical barriers that must be addressed through comprehensive policy frameworks.¹⁹

Community Engagement and Behavioral Change via Digital Platforms

Digital platforms leveraging social media, gamification, and behavioral economics principles can play a transformative role in community engagement, promote healthy behaviors, and raise awareness of stroke risk factors. These strategies use passive surveillance, peer support, and real-time feedback to drive behavior change at both individual and community levels.

Such interventions have proven to be cost-effective and scalable strategies for increasing population-level stroke awareness, with measurable reach and engagement metrics that inform policy decisions regarding resource allocation and public education strategies.^{2,21} Policy frameworks should therefore incorporate digital engagement strategies to extend the reach and effectiveness of prevention campaigns.²

Policy and System-Level Integration

National and regional campaigns have successfully applied digital and multimedia strategies to promote cardiovascular health and reduce stroke incidence. The Million Hearts Program²² is a national initiative in the United States co-led by the Centers for Disease Control and Prevention and the Centers for Medicare and Medicaid Services, to prevent 1 million heart attacks and strokes over 5 years.

The literature and policy recommendations advocate for a comprehensive digital approach for primary stroke prevention, including integrating digital tools into primary care, implementing population-wide mHealth initiatives, promoting community engagement, and fostering continuous quality improvement. It is fundamental to include social determinants of health when designing digital

strategies,² providing equitable infrastructure and access through supportive policies.^{2,18,19}

PreventS-MD and Stroke Riskometer: A Scalable Model for Primary Stroke Prevention Policy

The PreventS-MD platform²³ and Stroke Riskometer app,²⁴ developed in New Zealand and supported by 2 decades of research from the National Institute for Stroke and Applied Neurosciences at Auckland University of Technology, exemplify effective digital health integration into stroke prevention strategies. The Stroke Riskometer, a mobile/Web-based app, enables individuals to assess their personalized stroke risk using validated clinical algorithms, including the Framingham and INTERSTROKE-based frameworks. It estimates absolute and relative risk, provides tailored lifestyle recommendations, and has undergone clinical validation across diverse populations.^{19,23,25}

Building on this foundation, PreventS-MD is a modular, cloud-based platform that enables hospitals, labs, clinics, and technology vendors to integrate digital stroke and noncommunicable disease risk assessment into routine workflows. Currently deployed or in active roll-out across India, Singapore, Australia, and New Zealand, PreventS-MD is supported by collaborations with the Ministry of Health in Vietnam and Chulalongkorn University in Thailand, as well as partnerships in Australia and Singapore. The platform has supported multiple national and state-level collaborations, including government-sponsored clinical trials,²⁵ has been used in numerous research studies and has received endorsement from the World Stroke Organization.^{5,26}

Together, PreventS-MD and the Stroke Riskometer provide a compelling, evidence-based, and scalable ecosystem for governments and healthcare systems. Their adaptive and transformative potential is demonstrated in research, policy, clinical, and community settings; these tools contribute meaningfully to reducing the global burden of stroke.

Integrating Digital Health for Primary Stroke Prevention: The HEARTS Program Implementation in Southern Brazil

Digital platforms can transform primary health care by streamlining registration, risk assessment, and longitudinal management. In southern Brazil, a digital solution supporting the World Health Organization HEARTS enables structured triage, AI-assisted decision support, protocol-based care, and population-level dashboards, and is now being scaled through integration with primary care systems and hospital electronic records.

By supporting evidence-based decision-making, proactive follow-up, and real-time population health monitoring, this technology serves both clinicians and health managers. After initial success in southern Brazil, the tool is being scaled through integration with primary health

care systems and hospital electronic records. Implementation of HEARTS increased BP measurement from 20% to 70% and identified hypertension in 34% of patients, including 11% newly diagnosed and 2% with undetected atrial fibrillation. Since 2016, HEARTS has expanded to 33 countries, with standardized pathways in 28, achieving ≈65% hypertension control among treated patients across more than 7000 primary care centers, serving 45 million adults.²⁷

ACUTE CARE

Evidence-based digital strategies to strengthen acute stroke care policies are well established and encompass the prehospital, in-hospital, and systems levels.

Prehospital

Efficient prehospital stroke triage tools guide EMS to the most appropriate stroke center based on severity, enabling faster access to intravenous thrombolysis or mechanical thrombectomy (MT) and improving outcomes.²⁸ As part of integrated stroke policies, incorporating mobile apps and teleconsultations enhances decision-making accuracy in the field, reduces delays, and ensures that patients receive definitive treatment at the most appropriate facility.²⁹

The Field Assessment Stroke Triage for Emergency Destination³⁰ scale is a validated and user-friendly digital tool for assessing neurological deficits and identifying patients with large vessel occlusion, allowing direct transport to endovascular-capable centers and bypassing primary stroke centers. Its sensitivity for detection ranges from 48% to 78%, specificity from 61% to 89%, and negative predictive value up to 93%.^{31,32} The Rapid Arterial Occlusion Evaluation Computer-Assisted Triage scale is another prehospital stroke triage tool that integrates with EMS electronic records, streamlining patient assessment, scoring, and real-time data transmission, thereby improving communication and preparedness.³³ In a trial including over 1800 patients,³³ Rapid Arterial Occlusion Evaluation Computer-Assisted Triage demonstrated a strong correlation with in-hospital evaluation ($r=0.74$; $P<0.001$), with 84% sensitivity, 60% specificity, and good overall accuracy (area under the curve, 0.77). Higher Rapid Arterial Occlusion Evaluation scores were associated with direct admission to comprehensive stroke centers, greater odds of receiving MT (odds ratio, 2.40), and shorter onset-to-groin puncture times.

Field Assessment Stroke Triage for Emergency Destination and Rapid Arterial Occlusion Evaluation CAT enhances prehospital triage by directing patients to the most appropriate facility and supporting integrated stroke care networks, with implementation tailored to regional resources and system characteristics.

Stroke Center

AI for Acute Stroke Neuroimaging

AI-based tools that automatically identify ischemic areas and occluded vessels using only noncontrast brain CT can promote equitable access to acute stroke treatment by supporting nonstroke specialists without CT angiography. However, treatment decisions based solely on AI outputs remain unproven due to their pitfalls.³⁴ Also, implementation and maintenance costs may be prohibitive in low-resource settings.

Telemedicine for Acute Stroke

Telestroke, an evidence-based intervention endorsed by international societies,^{5,35} enables real-time remote consultation with stroke specialists to support rapid assessment and decision-making for intravenous thrombolysis and MT, particularly in hospitals lacking onsite expertise. It improves system efficiency by enabling timely, targeted transfers for MT or neurosurgical care, preventing nearly a third of unnecessary referrals while maintaining quality safety.^{5,36}

Evidence demonstrates that telestroke accelerates door-to-imaging interpretation, facilitates earlier specialist evaluations,³⁷ improves diagnostic accuracy, increases thrombolysis rates, and is cost-effective,^{38–41} achieving outcomes comparable to in-person care without exacerbating disparities.⁴² Standardized protocols through telemedicine reduce door-to-needle times^{43–45} and increase thrombolysis rates. One study reported an increase in rates from 6% to 16% in regional hospitals (odds ratio, 2.86; $P < 0.001$),⁴⁴ whereas another study documented an 82% rise within large integrated systems ($P < 0.001$).⁴⁸

The technology has proven reliable, contributing to education, workflow optimization, and improved physician-patient interaction, with no increase in complications or adverse events.^{37,44}

Telestroke has become a cornerstone of stroke systems of care, supporting coordination across diverse health networks.² Policy recommendations now focus on expanding telestroke coverage, including through interstate licensing and reimbursement reform, to address access disparities.^{35,37,46–49}

Furthermore, smartphones have emerged as a cost-effective and scalable method for telestroke consultation. Smartphone-based telemedicine platforms and the widespread availability of mobile videoconferencing, coupled with studies showing reliable clinical and neuroimaging data sharing,⁴¹ are similar to traditional telestroke tools and have decreased treatment times without compromising safety.⁵⁰ This helps make remote thrombolysis decisions and increases access to timely reperfusion therapies.^{50,51}

The implementation of mobile telestroke technology into EMS workflows expedites acute stroke care via rapid activation and coordination of stroke codes in the prehospital settings.^{2,51} Moreover, guidelines from the

American Heart Association suggest the use of mobile devices for telestroke consultations.^{2,35}

The ubiquity and affordability of smartphones make these solutions scalable across diverse healthcare environments, including rural areas, reducing disparities in access to acute stroke expertise, improving system efficiency,^{35,50,52} and supporting standardized quality metrics^{2,35,50} across different levels of care.

The impact of digital and telestroke solutions will remain limited unless coupled with strategies to reduce reperfusion costs and supported by global initiatives such as the World Stroke Organization Implementation Task Force⁵³ and Mission Thrombectomy (MT-2020 Plus)⁵⁴ that expand access to therapies and align digital innovation with sustainable health system financing.

Global Experiences With a Telestroke Program

Global experiences with telestroke programs demonstrate their vital role in expanding access to stroke care. In Chile, government-supported telestroke initiatives⁵⁵ successfully facilitated remote thrombolysis in isolated regions such as Easter Island and maintained consistent stroke care during the COVID-19 pandemic, highlighting system resilience. These digital strategies were integrated into national stroke policies, which have been linked to a roughly 15% to 20% relative decrease in stroke mortality at the population level.⁵⁶ In Brazil, the large-scale Telestroke Program launched in 2019⁵³ employs a mobile application to support hospitals without neurologists and facilitate prehospital transfers, enabling timely decision-making and reducing unnecessary transfers by 60%. The program has directly supported care for more than 7000 patients and provided 3000 thrombolysis treatments through teleconsultation across 10 states, demonstrating a scalable and cost-effective model that enhances access in resource-limited regions, including the Amazon region. The development of organized stroke systems and telestroke networks across the country has increased thrombolysis rates in public hospitals from under 3% to 7% to 15%, also leading to decreases in treatment delays.⁵⁷ In Ethiopia, under the World Stroke Organization's African Task Force Project, stroke units were established, and through the Telestroke Without Borders initiative,^{5,53} local teams received remote guidance from international experts to administer thrombolysis via mobile telemedicine. Despite significant infrastructural challenges, the program reduced mortality and improved outcomes for all stroke patients, demonstrating the effectiveness of integrated telehealth and organized stroke care in low-resource settings. Collectively, these diverse international experiences emphasize telemedicine's capacity to support stroke policies and improve stroke care delivery by enabling timely diagnosis and treatment through innovative and adaptable systems.

AI, Electronic Medical Records, and Quality Monitoring

Integrating structured forms into electronic health records, combined with AI tools, strengthens clinical workflows and quality management. Standardized data entry ensures information is captured in coded formats suited for protocol guidance, research, and quality improvement.¹⁵ Embedding care pathways directly into the electronic health record aligns documentation with clinical protocols, enables real-time decision support and adherence monitoring, and reduces the documentation burden. This automation also populates databases and patient registries without manual abstraction.^{58,59} AI technologies—especially natural language processing and machine learning—convert unstructured narratives into structured elements and analyze both data types to build predictive models, support decision-making, detect protocol deviations, calculate quality indicators, and feed real-time dashboards for continuous improvement.^{58–61} This improves data accuracy, completeness, and research utility while reducing clinician workload and burnout.^{15,61}

Successful implementation requires aligning structured documentation with clinical workflow and iteratively optimizing electronic health record design for usability.¹⁵ At scale, these systems enable standardized, anonymized data exchange, enhance real-world representativeness, and support robust research and national policy monitoring.^{59,61,62}

Georeferencing and Digital Tools for Improving Stroke Care Access

Georeferencing and geospatial analysis technologies significantly improve the identification of geographic disparities in stroke care, enabling targeted interventions to address regional service gaps. Mapping existing stroke centers, along with demographic and infrastructural data, helps policymakers identify underserved areas and prioritize the creation of new stroke centers where demand is highest. However, simply designating new stroke centers is not enough; addressing infrastructural shortcomings, such as limited computed tomography scanner availability, must be a parallel priority. Geospatial modeling in India and Ontario has revealed key regional differences in access to intravenous thrombolysis and MT, measuring the proportion of the population within timely reach of stroke centers and pinpointing areas with limited or no access.^{54,63} These analyses justify more precise resource allocation and the strategic implementation of telemedicine and mobile stroke units, which have been shown to expand access to reperfusion therapies and enhance stroke outcomes in underserved populations.⁶³ Integrating geospatial digital health tools into stroke system planning and policy development, governments can strategically allocate resources, optimize stroke networks, and ultimately improve access to

acute stroke treatments for all individuals, regardless of geographic location.^{54,63,64}

MAPSTROKE: A Digital Health Case Study

The MAPSTROKE offers a compelling model on how digital health solutions can be integrated into stroke policies to improve access to acute stroke care. A computational strategy was developed and applied to pinpoint optimal locations for new acute stroke centers across 9 Latin American countries/regions, considering existing local infrastructure, population density, and transportation networks. The solution successfully mapped the coverage of existing centers, identified candidate locations for new centers, and proposed establishing artificial points to maximize population coverage, targeting up to 95% coverage (Figure 1).

This strategy utilizes a geographic information system framework, incorporating: (1) geolocation data of hospitals with stroke treatment capabilities; (2) road networks using open access data to model realistic travel times; (3) population data sets for demographic analysis; (4) catchment areas: 45-minute drive radii around hospitals, reflecting guideline recommendations for stroke care access.

MAPSTROKE quantifies disparities in stroke care access and enables data-driven resource allocation, regional network design, and evaluation of policy and infrastructure investments.

REHABILITATION

Several key strategies are recommended to integrate digital tools into stroke policies for poststroke care.

Telerehabilitation and Remote Monitoring

Telerehabilitation, delivered synchronously or asynchronously, achieves outcomes comparable to in-person rehabilitation for motor recovery, speech/language therapy, cognition, and management of depression and caregiver stress. Technology-based home programs and digital support systems further enhance physical, cognitive, and emotional function, self-care, adherence, and risk factor control, with demonstrated benefits for lipid and BP management.^{35,47,65}

Remote monitoring using patient-generated health data (eg, wearables, home BP monitors) enables continuous assessment and personalized interventions, particularly when integrated with electronic health records and decision-support algorithms, thereby strengthening care coordination and quality assessment.^{35,47}

Beyond wearables, contactless environmental sensors using computer vision and ambient monitoring can noninvasively detect atrial fibrillation, carotid stenosis, and fall risk in private or public settings, particularly benefiting older, institutionalized, and underserved populations where wearable adherence is limited.^{66–68}

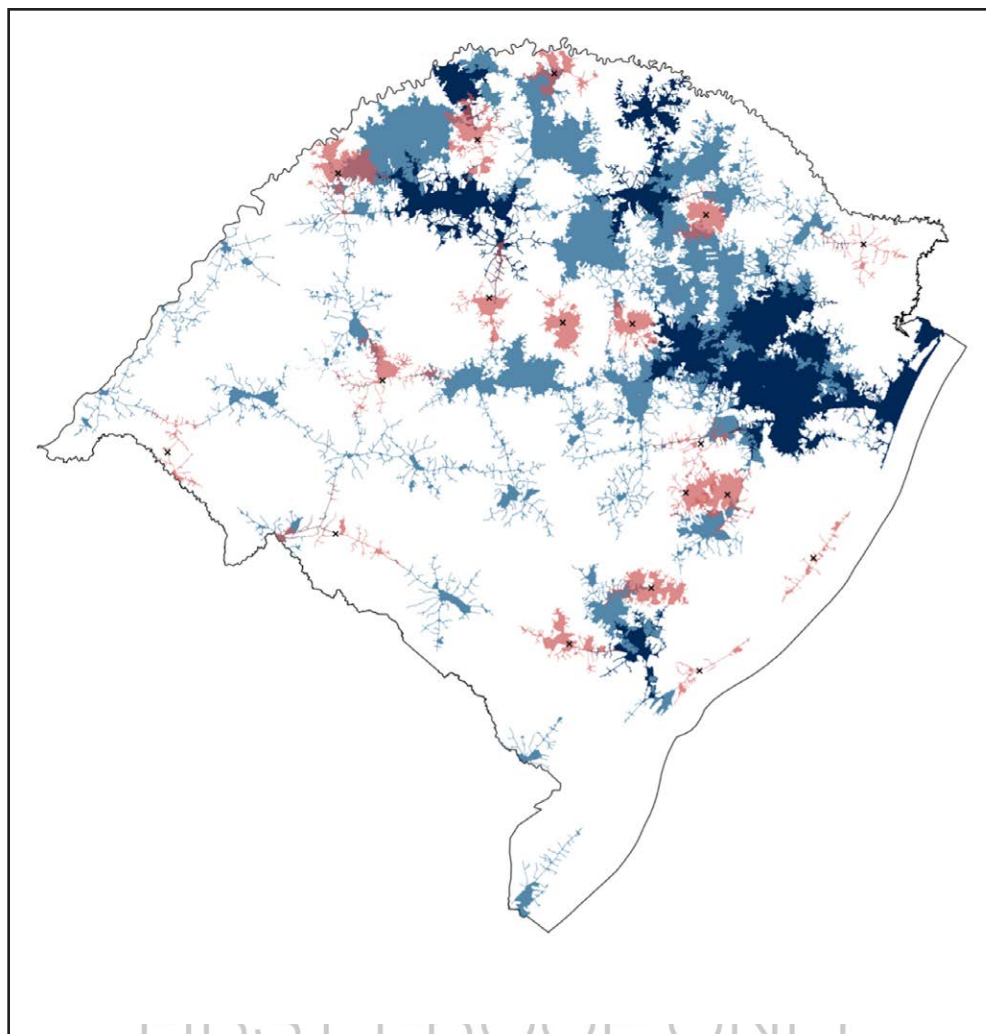


Figure 1. Output of the MAPSTROKE computation strategy.

For this region in Brazil, based on a list of hospitals that provide acute stroke treatment (acute stroke centers [ASCs]), 45-minute isochrones were generated to determine the current population coverage (dark blue). Suppose the current coverage is below the desired threshold (eg, 95%). In that case, the strategy selects potential ASCs (light blue isochrones) and, in a second step, marks artificial points (X marks, red isochrones) for the ideal location of new institutions.

Evidence-based policies should prioritize telerehabilitation, person-centered approaches, equity-focused access, implementation science, and infrastructure development.^{2,65,69–72} Further implementation research is needed to refine intervention protocols, validate virtual outcome measures, integrate neuromodulation or conventional techniques, and develop cost-effective models for clinical practice.^{8,72}

Figure 2 shows digital tools that can be used at each level of care to support stroke policies, and Table S1 outlines how to implement them.

EDUCATION

Integrating education into digital health stroke policies requires alignment with existing healthcare infrastructures and adaptation to local contexts, resources, and workforce capacity, especially in low-resource settings

where digital inequities are most pronounced.^{73,74} Public-facing digital platforms—such as social media, mHealth applications, and online libraries—can enhance awareness of stroke symptoms, prevention, and timely treatment, especially when tailored to different populations and incorporating behavioral strategies such as gamification.^{2,19,75} For healthcare professionals, blended learning models that combine group-based and e-learning approaches support the adoption of digital tools, including electronic medical records. Iterative, context-sensitive education programs guided by frameworks can manage complexity and ensure successful integration.⁷⁶ Providing education across all levels of care and developing evidence-based national guidelines for stroke management should remain central policy priorities.

Patient-centered design and codevelopment are essential to ensure usability, trust, and accessibility, with valued features including credible information, personal

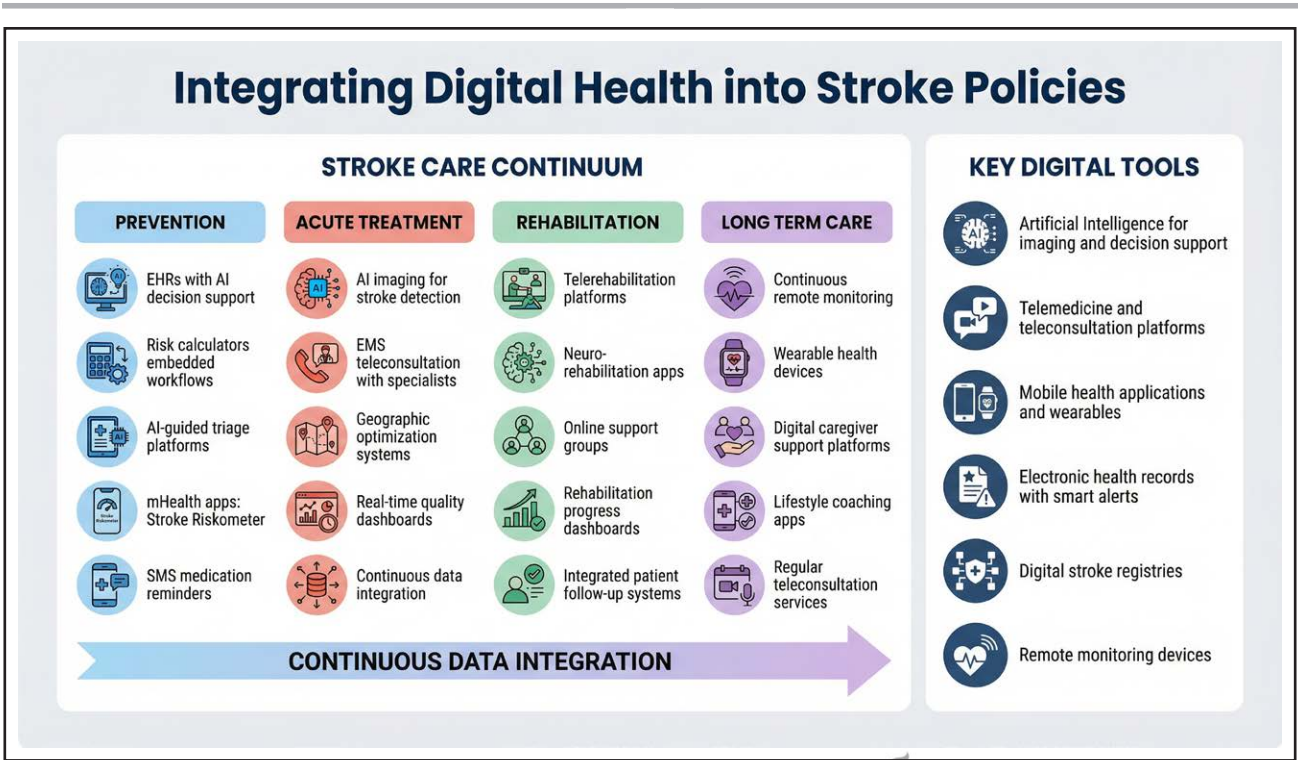


Figure 2. Key digital tools to integrate into stroke policies. This figure was generated with artificial intelligence (AI) assistance (Manus AI platform) and verified by the authors. EMS indicates emergency medical services.

health records, and online rehabilitation support.⁷⁵ Policies should mandate iterative evaluation, ethical and regulatory safeguards, and cross-sectoral partnerships to address privacy, interoperability, and equity, fostering inclusive ecosystems across the continuum of stroke care.^{73,74,77}

COST

Digital platforms that use time-driven activity-based costing and risk-adjusted models enable precise estimation of patient-level costs across the stroke care continuum, enabling value-based reimbursement linked to clinical complexity and outcomes.⁷⁸ Economic evaluation frameworks—particularly cost-effectiveness and cost-utility analyses—are increasingly applied to quantify incremental cost per health outcome (eg, QALY or DALY). Such analyses should adopt a societal perspective, incorporating direct and indirect costs (caregiver time, productivity loss, transportation), as well as patient out-of-pocket expenditures (including medications, diagnostics, copayments, informal care, and travel costs), which are frequently excluded from indirect cost analyses but represent a substantial financial burden, particularly in LMIC settings.⁷⁹

Telehealth and telestroke services are cost-effective due to expanded access, fewer interhospital transfers, and more efficient use of resources.^{47,80} For instance, telestroke hub-and-spoke networks have been

associated with annual cost savings of US\$358 435 overall, with each spoke site saving ≈US\$109 080.⁴⁰ More recent data on acute stroke care similarly support its cost-effectiveness from both societal and health system perspectives.⁴¹ In a systematic review,⁸¹ telestroke was a cost-saving/cost-effective intervention in 5 out of the 8 studies. In rural China, telestroke was the main strategy, saving US\$627 and gaining 0.0925 quality-adjusted life years per patient, with sensitivity analyses confirming the results. In rehabilitation, telerehabilitation models report mean cost savings ranging from US\$1200 to US\$6500 per patient compared with conventional rehabilitation.⁸²

Cost modeling demonstrating public healthcare savings informed the passage of the United States Furthering Access to Stroke Telemedicine Act (2018), enabling nationwide telestroke reimbursement and accelerating telestroke adoption as reflected in Medicare claims.⁸³

From a macroeconomic perspective, stroke and cerebral microvascular injury are increasingly recognized by economic and financial policymakers as early drivers of dementia and long-term dependency. Underinvestment in stroke prevention and timely acute care will substantially increase future societal costs, particularly in rapidly aging populations.⁸⁴

Public-facing digital tools, including social media campaigns and mHealth interventions, offer low-cost, high-impact strategies for stroke awareness and prevention.^{21,54} Systematic reviews from chronic disease settings show these interventions can be cost-effective,

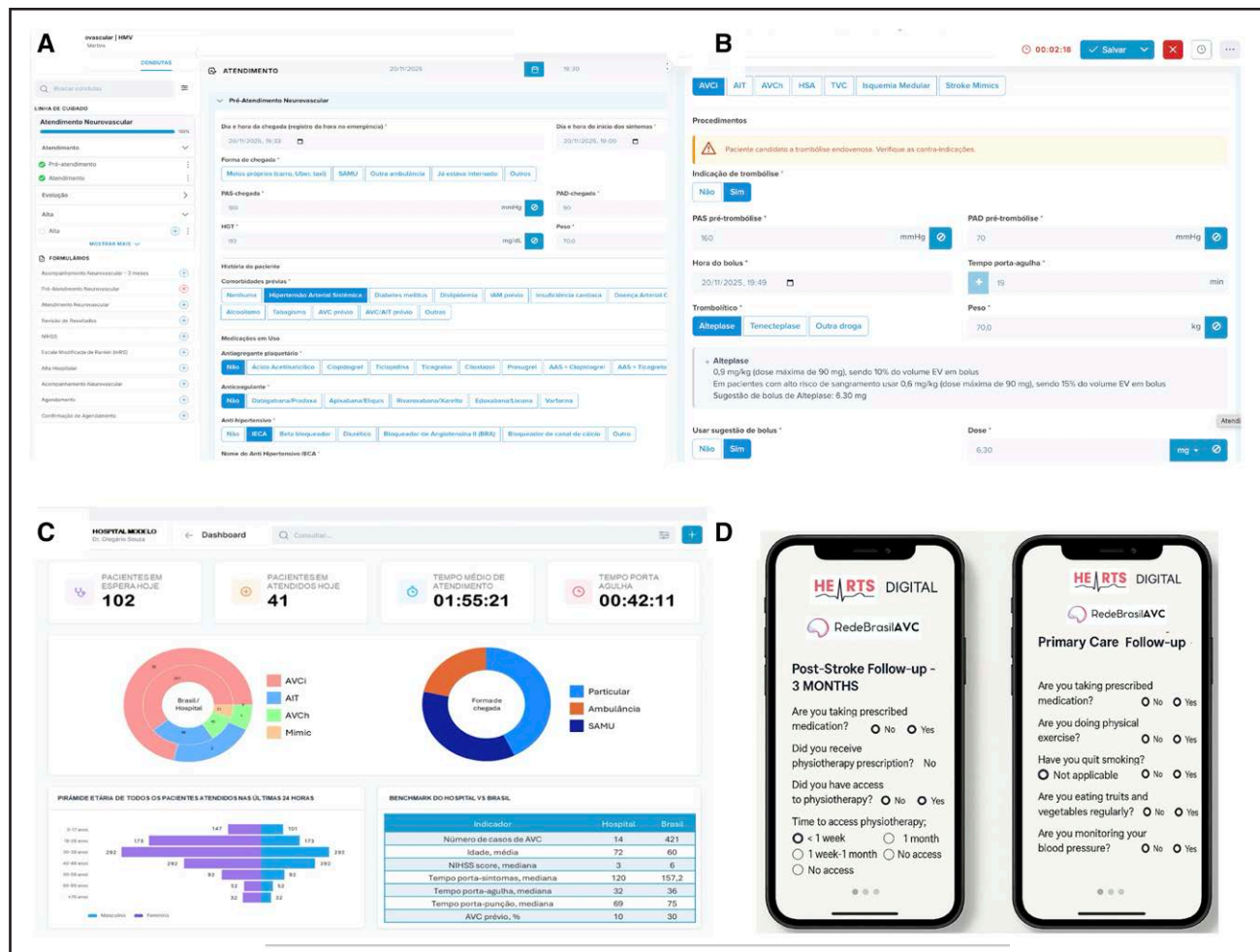


Figure 3. Digital stroke care pathway.

A and **B**, Artificial intelligence (AI)-enhanced electronic health records with prestructured forms that support protocols and generate a stroke database and quality indicators. **C**, Quality-indicator dashboard. **D**, Patient follow-up app for primary care and poststroke monitoring. mRS indicates modified Rankin Scale; and NIHSS, National Institutes of Health Stroke Scale.

often achieving favorable cost-per-QALY ratios.⁸⁵ However, cost-effectiveness findings are difficult to generalize across countries due to variations in unit costs, health system capacity, and willingness-to-pay thresholds. Many studies also lack long-term horizons, indirect cost estimates, or sensitivity analyses, potentially underestimating benefits. Upfront investments in infrastructure, connectivity, and workforce training can be significant, and maintenance or software updates often remain unfunded beyond pilot phases.

To achieve sustainability, policy frameworks must integrate economic evaluation into digital health planning from inception. This includes using cost-effectiveness and budget impact analyses to guide scale-up beyond pilots. Governments and payers should invest in interoperable data infrastructure, harmonized cost standards, and modernized reimbursement mechanisms that reward outcomes rather than volume. Digital stroke programs show that modeling cost savings—like fewer transfers, shorter stays, and better access to reperfusion—can

support reimbursement reform and adoption. Hybrid financing models—combining public funding, outcome-based reimbursement, and private coinvestment—can help amortize initial costs while aligning incentives for innovation and efficiency and facilitating the transition from short-term pilots to sustained, system-wide implementation.^{73,80}

MODELS INTEGRATING THE STROKE CARE PATHWAY

Australian Stroke Program

The Australian national stroke program exemplifies the application of a learning health system framework, leveraging digital infrastructure to deliver real-time feedback, align care with best practice standards, and drive continuous improvement. This approach has demonstrated measurable advances in stroke care and provides a model for policy development and system-wide quality

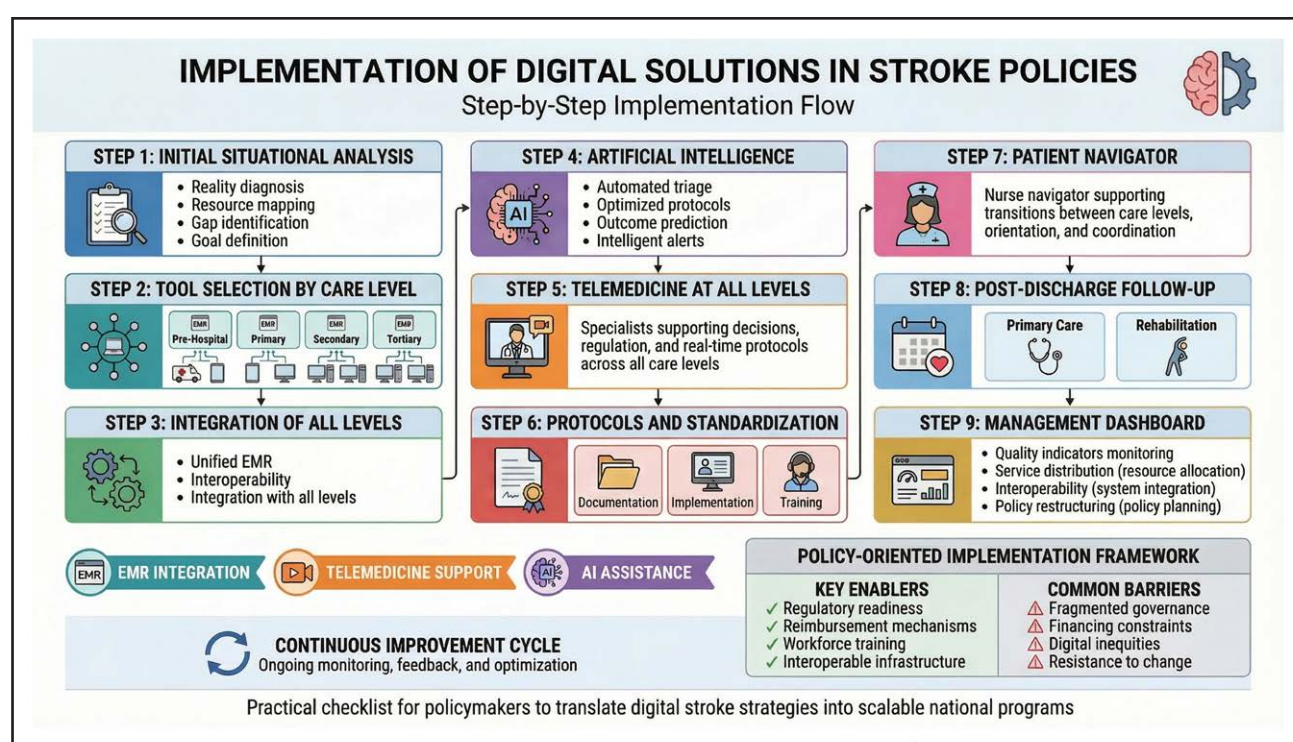


Figure 4. Policy-oriented implementation roadmap for integrating digital health into stroke policies across the continuum of care.

To enhance actionability, the figure presents a policy-oriented implementation roadmap that identifies key enablers and barriers and outlines priority steps for integrating digital health tools into stroke policies. This figure was generated with artificial intelligence (AI) assistance (Manus AI platform) and verified by the authors.

enhancement.⁸⁶ Key components include stakeholder engagement, research integration, data-driven practice, and evidence-based implementation, underscoring the shift from viewing research as an end point to applying it as a mechanism for improving healthcare.

Umbrella Project: European Model for Integrated Digital Stroke Care

Integrated digital health solutions are also embedded in the European Stroke Action Plan.^{77,87} Launched in 2025, the Umbrella Project⁸⁸ is a pan-European initiative in implementation, developing a standardized, patient-centered stroke care model supported by interoperable digital infrastructure, regulatory alignment, and AI integration within a harmonized stroke policy framework, aiming to improve access, prevention, diagnosis, treatment, and outcomes across diverse healthcare systems.⁷⁶

The project standardizes real-world stroke data across imaging, wearables, and virtual rehabilitation, enabling real-time analysis, quality benchmarking, and secure AI development through federated learning. By combining interoperable communication tools, workforce education, and a regulatory roadmap, Umbrella aims to ensure sustainability by embedding digital health within national strategies, aligning with system priorities, reducing

cross-country disparities, and informing scalable stroke policy implementation.

Golden Bridge II

The Golden Bridge II⁸⁹ was a cluster-randomized PROBE trial across 77 Chinese hospitals evaluating a clinical decision support system developed by the author, including AI-assisted imaging, cause classification, and treatment recommendations. The results showed that an AI-driven decision-support tool integrated into stroke care significantly reduced 3-month composite vascular events by 30% and improved quality-of-care scores.

Brazilian Digital Stroke Care Pathway

Although Brazil launched a national acute Stroke Program in 2012, further integration across the stroke care pathway is needed. A digital health strategy is proposed to connect primary care, EMS, hospitals, rehabilitation, and patients (Figure 3). Key components include: early risk detection in primary care and management through decision-support software; optimized emergency response using integrated electronic records and telemedicine; remote postdischarge monitoring via mobile apps; and real-time quality improvement through structured data and dashboards at all levels of care. Integrating these digital tools enables continuous

Table. Key Recommendations for Implementing Digital Health in Stroke Policies

Key domain	Policy recommendations
Governance	• Embed digital health into national stroke plans and health strategies. • Establish national and regional stroke registries integrated with the stroke care pathway for monitoring quality and outcomes. • Foster cross-sectoral partnerships (government, academia, industry, nongovernmental organizations).
Workforce	• Train and certify health professionals in digital health tools (telemedicine, telerehabilitation, AI-assisted EHR). • Develop blended learning programs (online+onsite). • Create incentives for digital tool adoption in practice.
Financing	• Include digital stroke services under public insurance/Universal Health Coverage. • Ensure sustainable reimbursement models for telestroke, telerehabilitation, and digital monitoring. • Invest in cost-effectiveness studies to guide resource allocation.
Infrastructure	• Expand access to broadband, cloud, and mobile devices. • Ensure interoperability of platforms (EHR, registries, telehealth). • Promote cybersecurity and data sovereignty standards.
Regulation	• Create standards for data privacy, interoperability, and AI ethics. • Establish clear pathways for AI certification and validation. • Develop regulatory frameworks for cross-border telemedicine and digital data sharing.
Public engagement	• Ensure usability, accessibility, and inclusivity of digital health tools. • Promote codesign with patients and caregivers. • Launch digital public awareness campaigns using social media, gamification, and mobile outreach.

AI, artificial intelligence; and EHR, electronic health records.

evaluation of stroke care, improving quality, efficiency, and equity across the health system.

ENABLING FACTORS FOR POLICY IMPLEMENTATION

Successful integration of digital health into stroke care requires investment in communications infrastructure, usability-focused design for older adults and patients with neurological impairments, and alignment with reimbursement policies. Interoperability with existing healthcare systems is essential to ensure scalability and sustainability.^{2,47} Effective scale-up also relies on strong governance and regulatory frameworks at national and regional levels aligned with international standards, such as the World Health Organization guidance on digital health and AI principles on health data governance, to promote secure data exchange, protect patient privacy, and ensure responsible use of AI, especially in hub-and-spoke and cross-jurisdictional stroke networks.

Equity remains a critical challenge, requiring policies that address gaps in internet access, device availability, and digital literacy, especially among vulnerable populations. Equity-oriented digital strategies should include task-shifting supported by digital decision tools, low-cost smartphone-based telemedicine, phased public financing, and integration of digital stroke tools into existing primary care and emergency systems, alongside culturally tailored programs and sustained reimbursement mechanisms to reduce disparities and extend the reach of digital health interventions.⁷¹

The Table outlines the elements and actions needed to incorporate digital health into stroke policies. Figure 4 presents a policy-oriented implementation framework outlining stepwise actions to translate digital stroke

strategies into scalable and sustainable national and regional programs.

CONCLUSIONS

Digital tools play a vital role in strengthening stroke-related health policies throughout the entire continuum of care. Telemedicine, social media outreach, learning health systems, and patient-centered platforms improve public awareness, prevention, acute care coordination, and long-term management.^{2,21,77,86} Digital systems also improve patient engagement, adherence, and outcomes.⁶⁹ Major guidelines endorse these tools for education, surveillance, and the dissemination of best practices, supporting smarter resource allocation.²

However, implementation is inconsistent due to key barriers, such as fragmented governance, reimbursement, and regulatory gaps, interoperability limitations, workforce shortages, and digital inequities. Addressing these barriers calls for coordinated policy efforts that emphasize regulatory readiness, sustainable financing, interoperable infrastructure, workforce training, and design centered on equity.

Overall, digital strategies are essential enablers for designing, implementing, and evaluating stroke policies,^{2,21,77,86} helping overcome geographic and organizational barriers and expand access to timely, effective care.¹⁹

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Dr Martins conceptualized the manuscript and wrote the initial and final versions. All other authors provided critical revisions to the content and approved the final version.

Sources of Funding

None.

Disclosures

Dr Martins reports grants from the Ministry of Health of Brazil. Dr Feigin reports other intellectual property for the Stroke Riskometer app and other intellectual property pending for PreventS-MD. L. Carbonera reports compensation from Boehringer Ingelheim for other services; compensation from Allm Inc. for consultant services; and travel support from IschemaView Inc. Dr Nair reports other intellectual property issued for PreventS-MD and Stroke Riskometer are trademarks of Auckland University of Technology, New Zealand. Dr Sposato reports compensation from Pfizer for other services; compensation from Boehringer Ingelheim for other services; compensation from Western University (Canada) for other services; compensation from W. L. Gore & Associates Inc for other services; and grants from Medtronic. Dr Nogueira reports compensation from Genentech for consultant services; compensation from Hybernia for consultant services; stock options in Perfuzo; compensation from Genentech for consultant services; compensation from Medtronic USA Inc for consultant services; compensation from Ceretrieve for consultant services; compensation from Stryker for consultant services; compensation from Anaconda Biomed for consultant services; compensation from viz-AI for consultant services; compensation from Merck KGaA for consultant services; compensation from Prolong Pharmaceuticals for consultant services; compensation from Perfuzo for consultant services; compensation from Prolong Pharmaceuticals for consultant services; compensation from Brainomix for consultant services; stock options in Truvic; compensation from Boehringer Ingelheim for consultant services; compensation from Anaconda for consultant services; stock options in Ceretrieve; compensation from viz-AI for consultant services; stock holdings in Quantanosis AI; compensation from Cerenovus for consultant services; stock options in Viseon Inc; compensation from Philips for consultant services; compensation from Brainomix for consultant services; stock options in Reist/Q'Apel Medical; stock options in Vesalio; compensation from Biogen Inc for consultant services; grants from Cerenovus; compensation from Vesalio for consultant services; compensation from Medtronic USA Inc for consultant services; stock options in Cerebrotech; stock options in Brainomix; compensation from Imperative Care for consultant services; compensation from Vesalio for consultant services; compensation from Astrocyte for consultant services; stock options in Unity Medical; compensation from Imperative Care Inc for consultant services; compensation from Ceretrieve for consultant services; compensation from RapidPulse for consultant services; compensation from Cerebrotech for consultant services; compensation from Phenox for consultant services; compensation from Stryker Corporation for consultant services; stock options in Corindus Inc.; compensation from Perfuzo for consultant services; compensation from Sosome for consultant services; grants from Stryker; compensation from Shanghai Wallaby for consultant services; compensation from Corindus Inc. for consultant services; stock options in viz-AI; compensation from RapidPulse for consultant services; compensation from Cerenovus for consultant services; stock holdings in Piraeus Medical; stock options in Perfuzo; compensation from Biogen, Inc, for consultant services; compensation from Synchron for data and safety monitoring services; stock holdings in Brain4Care; stock options in RapidPulse; compensation from Corindus Vascular Robotics for consultant services; stock options in viz-AI; compensation from NeuroVasc Technologies Inc for consultant services; compensation from phenox Inc. for consultant services; and compensation from Takeda Pharmaceuticals for consultant services. The other authors report no conflicts.

Supplemental Material

Supplemental Methods
Table S1

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