The Role of Telemedicine in Improving Stroke Management

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ABSTRACT

The growing demand for timely and high-quality medical services had driven the emergence of telemedicine as an innovative healthcare solution. Telemedicine was defined as the use of technology to deliver patient care remotely, enabling physicians to communicate with and manage patients in distant locations through telecommunications systems without the need for in-person visits. Stroke is recognized as a medical emergency requiring prompt diagnosis and treatment to improve survival and functional outcomes. The purpose of this study was to evaluate the role of telemedicine in enhancing stroke management within the U.S. healthcare system. A systematic review of 16 peer-reviewed articles published in English between 2006 and 2019 was conducted. The selected studies focused exclusively on data derived from the United States. Findings from the review showed that telemedicine significantly reduced treatment times for stroke patients, resulting in better clinical outcomes. It also proved to be a cost-effective approach to delivering rapid and efficient stroke care. The analysis further revealed that approximately 55% of Americans had access to primary stroke care centers within 60 minutes; however, only about half of these hospitals had an on-site neurologist. Telestroke, or stroke-specific telemedicine, emerged as a key strategy for bridging this gap by connecting non-specialized hospitals with neurologists and specialized stroke centers in real time. Despite its effectiveness, further efforts were required to address persistent challenges such as interstate licensing restrictions and technical issues encountered during remote consultations.

BACKGROUND

Benjamin et al. (2019) reported that approximately 795,000 Americans experience a new or recurrent stroke each year—equating to one stroke every 40 seconds. Given these alarming statistics, the growing strain on the U.S. healthcare system underscores the urgent need for innovative approaches to improve access and efficiency. Telemedicine has emerged as a viable solution to address key limitations such as geographic barriers to emergency care and the shortage of skilled neurologists (Amar & Deth, 2011). The advancement and integration of telemedicine have been driven by the increasing demand for timely, high-quality medical services. Recurrent strokes are particularly concerning, as they are associated with increased healthcare costs, higher mortality, and long-term disability (Barr et al., 2017). Telemedicine, through real-time remote consultations, offers an opportunity to enhance the management and follow-up of stroke patients, thereby potentially reducing recurrence rates.

Recent progress in information technology security has further supported the safe transfer of sensitive medical data. These technological advancements have transformed healthcare delivery by enabling the secure exchange of confidential health information across distances (Amar & Deth, 2011). Telemedicine, defined as the use of telecommunications technology to deliver healthcare remotely, broadens access to specialized care—especially for patients in underserved or rural regions. One of the most innovative applications of telemedicine in stroke care is the mobile stroke unit (MSU)—an ambulance equipped to provide immediate diagnosis and treatment

to stroke patients before hospital arrival. Through telestroke (stroke-specific telemedicine), neurologists can communicate directly with MSU teams during patient transport, utilizing telecommunications infrastructure to guide treatment en route to the stroke center.

Preventing recurrent strokes depends heavily on patient behavior and adherence to lifestyle modifications. Many stroke survivors struggle with long-term adherence to rehabilitation programs due to inadequate follow-up care. Studies suggest that substituting one day of inpatient therapy with a telemedicine-based stroke coaching model could improve long-term outcomes, enhance control of risk factors, and promote better physical activity, dietary habits, and medication adherence (Barr et al., 2017). However, more research is needed to evaluate the long-term effectiveness of such telecoaching programs. Immediate treatment is critical for acute stroke patients, and telestroke networks have demonstrated significant potential in improving management outcomes, particularly in acute ischemic stroke (Bettermann & Sinha, 2019). Telestroke programs enable non-specialized stroke centers to access real-time expertise from neurologists, improving care quality and timeliness (Audebert & Muller-Barna, 2012). In telestroke management, an experienced neurologist performs remote neurological examinations via videoconferencing and interprets neuroimaging through teleradiology to establish an accurate diagnosis. These consultations can occur both during patient transport and at hospitals with limited access to neurologists. Because treatment outcomes are highly time-sensitive, robust and reliable information technology support is essential for effective telestroke operations.

This study aims to evaluate the role of telemedicine in improving stroke management through a review of peer-reviewed literature. Articles were selected based on relevance to the research question using targeted search terms and filters. The evidence indicates that telestroke enhances evaluation, diagnosis, management, and delivery of remote stroke care (Peter & Olivia, 2006). Moreover, telemedicine interventions have been associated with timely treatment initiation, improved patient self-management, and higher satisfaction with care (Hopp et al., 2006).

LITERATURE REVIEW

According to Benjamin et al. (2019), approximately 90% of stroke cases are attributable to modifiable risk factors such as obesity, hypertension, renal dysfunction, hyperlipidemia, and hyperglycemia. Behavioral factors—including smoking, unhealthy diets, and sedentary lifestyles—account for about 74% of these modifiable risks, while air pollution contributes an additional 29% to overall stroke risk. Data from the Nationwide Inpatient Sample revealed a rise in the incidence of acute ischemic stroke (Benjamin et al., 2019). The increase was observed in both males and females, particularly among young adults aged 18–54 years from certain ethnic groups. Between 1995 and 2012, stroke hospitalization rates rose notably among males aged 18–34 and 35–44 years.

A significant proportion of the global stroke burden occurs in low- and middle-income countries. Although global age-adjusted mortality rates for both ischemic and hemorrhagic strokes declined between 1990 and 2015, there has been a concurrent increase in disability-adjusted life-years (DALYs) lost among stroke patients worldwide. The evolution of telehealth has significantly enhanced the capacity of rural and community hospitals to treat acute stroke patients in a timely, safe, and effective manner (Audebert & Hess, 2013). The shortage of stroke specialists in many developing countries has led to an increased demand for neurologists. Telestroke—a form of telemedicine specifically designed for stroke care—has emerged as an effective solution to bridge this gap (Audebert, Hubert, & Muller-Barna, 2014). Studies show that telestroke services are more frequently utilized in rural and super-rural areas compared to urban centers, with rural clinics more likely to adopt and integrate these services into patient care (Switzer et al., 2018).

Patients with acute stroke often experience severe neurological deficits and poor prognoses. Prompt medical attention is therefore critical. Telestroke networks enable the rapid evaluation and management of such patients and have demonstrated potential in improving outcomes for those with acute ischemic stroke (Betterman & Sinha, 2019). In recognition of the importance of timely intervention, the American Heart Association and the American Stroke Association now recognize stroke centers achieving a door-to-needle time (DNT) of less than 60 minutes for alteplase administration (Avins et al., 2017). Comparative studies between telemedicine vascular neurologists and on-site specialists have shown similar diagnostic accuracy, though technical

challenges—such as poor internet connectivity—remain a concern (Bowry et al., 2017). The use of telemedicine in stroke management provides several advantages, including timely access to specialists, improved patient outcomes, and expanded care for patients in non-specialized centers (Audebert & Muller-Barna, 2012). Telestroke systems can also reduce prehospital delays and facilitate faster in-hospital workups by alerting stroke care teams in advance.

Emerging innovations, such as in-transit telestroke consultations and mobile stroke units, have proven cost-effective in delivering rapid diagnosis and treatment to stroke patients (Gary et al., 2013). Early intervention with intravenous thrombolytics, particularly alteplase, within the first hour of stroke onset has been shown to significantly improve outcomes. Although telestroke success may be partly associated with timely alteplase use, further evidence is needed to establish a definitive correlation (Avins et al., 2017). Sustaining and expanding telestroke networks will require addressing several systemic and regulatory barriers. Licensing requirements currently vary by state, creating administrative burdens for telestroke providers. A national or multistate licensing framework could enhance efficiency and sustainability (Demacerschalk & Switzer, 2012). Flexibility allowing inter-state consultations and collaborative decision-making would further strengthen telestroke implementation. Technical issues, such as difficulty accessing neuroimaging data, can delay clinical decisions and highlight the need for continuous information technology support given the unpredictable nature of acute stroke events. Moreover, reimbursement challenges and rigid regulatory policies discourage wider adoption of telemedicine. A lack of clear legal frameworks and flexible policies continues to limit the potential of telemedicine in stroke management (Randy & Rita, 2016).

In summary, while modifiable risk factors remain central to stroke prevention, technological innovations like telestroke offer promising avenues for improving access to expert care, reducing treatment delays, and enhancing outcomes—particularly in underserved and rural populations.

METHODOLOGY

This study employed a systematic review approach to evaluate the role of telemedicine in improving stroke management within the United States. The research involved a comprehensive search and selection of peer-reviewed articles that were most relevant to the research question. Articles were identified using specific search filters and a combination of key terms to ensure relevance and accuracy. The search was restricted to studies published in English and focused exclusively on data related to the U.S. healthcare system. A total of 16 peer-reviewed articles**,** published between 2006 and 2019**,** were selected for inclusion. The search strategy incorporated a wide range of keywords related to telemedicine and stroke care, including *telehealth, telemedicine, telecare, telestroke, cerebrovascular accident, stroke treatment, medical technology, emergency medical services, tele-monitoring, telerehabilitation, video conferencing, tele-assistance,* and *health outcomes,* among others. Additional search terms were used to capture aspects of healthcare delivery and policy such as *regulation, law, policy, legislation,* and *interoperability issues*

Articles were sourced from multiple academic databases and journals to ensure comprehensive coverage of relevant literature. These databases included CINAHL Complete**,** Academic Search Ultimate**,** Gale Academic OneFile**,** Academic Search Premier**,** MasterFILE Premier**,** Information Science & Technology Abstracts**,** IEEE Xplore Digital Library**,** ScienceDirect**,** Gale Health and Wellness, and Gale OneFile: Health and Medicine**.** The final selection of articles primarily addressed telestroke applications in human populations, focusing on areas such as door-to-needle time in acute stroke management, teleneurology evaluation during patient transport, identification of barriers to telestroke implementation, and assessment of telestroke network effectiveness. This rigorous selection process ensured that the included studies provided high-quality, relevant data for analyzing the impact and challenges of telestroke practice within the U.S. healthcare system.

RESULTS

Recent studies have demonstrated the growing utility of telemedicine and telestroke systems in improving the management and outcomes of acute ischemic stroke. Collectively, these studies highlight the effectiveness, feasibility, and evolving applications of telestroke technology in clinical practice.

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Almeida et al. (2019) evaluated the JOIN Application smartphone system, a cost-effective digital platform for rapid clinical and neuroimaging data sharing aimed at supporting decision-making in stroke management. Conducted at a university hospital in Brazil between December 2014 and December 2015, the study reported a significant reduction in door-to-needle times following implementation. Notably, remote application-based clinical decisions demonstrated accuracy comparable to those made in the physical presence of stroke specialists, underscoring the potential of mobile-based telestroke systems to enhance timely intervention.

In the study by Demaerschalk and Switzer (2012), the authors emphasized that beyond audiovisual communication and teleradiology, telestroke technology now integrates comprehensive clinical documentation and generates billable physician notes. However, they also observed that the inability to view neuroimaging data could delay decision-making, highlighting the critical role of robust IT infrastructure and continuous technical support for effective telestroke practice.

Audebert, Hubert, and Müller-Barna (2014) analyzed 25 studies on telestroke systems — nine on prehospital management, fourteen on stroke unit treatment, and two describing networks in developing countries. Their findings indicated a global shortage of stroke specialists, particularly in developing regions. Although telestroke shows strong potential to expand access and treatment capacity, the study concluded that its implementation remains limited and underutilized, especially in low-resource settings.

Switzer et al. (2018) explored the adoption of telestroke services among Medicare fee-for-service beneficiaries in rural and urban areas of the United States between 2008 and 2015. Using administrative claims data from the Centers for Medicare and Medicaid Services (CMS), they found that telestroke utilization increased significantly in rural and “super-rural” regions compared with urban areas. Interestingly, male patients were more likely than female patients to receive telestroke services during the study period. These findings suggest a gradual but meaningful diffusion of telestroke technology into underserved rural populations.

Similarly, Peters and Olivia (2006) investigated the feasibility of telemedicine in stroke management. Despite limited data, their study demonstrated that telemedicine can be an acceptable, reliable, and feasible approach for acute stroke care, providing early evidence supporting its integration into clinical workflows.

Further evidence of telestroke’s clinical impact was provided by Bettermann and Sinha (2019), who examined the role of telemedicine networks in managing moderate to severe acute ischemic stroke. Their results confirmed that telestroke networks enhance hospital management of such cases, improving both efficiency and treatment outcomes.

In addition to acute management, telestroke applications have expanded into post-stroke rehabilitation and follow-up care. Barr et al. (2017) evaluated the long-term outcomes of stroke survivors participating in a telemedicine stroke coach program designed to promote risk factor control and healthy lifestyle modifications. Among 126 community-dwelling stroke survivors aged 50 years and older, those enrolled in the six-month telehealth program demonstrated improved physical activity, diet adherence, and medication compliance. The model also allowed patients to receive neurological follow-up in their homes, suggesting that telemedicine can effectively support secondary stroke prevention.

The importance of rapid intervention was reinforced by Belt et al. (2016), who compared the efficacy and cost-effectiveness of in-transit teleneurology during patient transport via mobile stroke units. Despite intermittent connectivity challenges, telemedicine-assisted transport significantly reduced treatment times and improved patient outcomes, emphasizing the economic and clinical benefits of real-time remote assessment.

Hopp et al. (2006) investigated the opportunities and barriers to telemedicine adoption within a network of seven Veterans Health Administration centers and 23 clinics across the U.S. Midwest. Key opportunities identified included timely access to care, enhanced self-management, and higher patient satisfaction. However, barriers such as patient preference for in-person visits, limited technical literacy, and the need for staff training persisted. The study concluded that telemedicine adoption is driven largely by human factors — particularly provider readiness and administrative support — rather than technological limitations. Their findings, derived from a large cohort of 241,000 veterans (95% male; mean age 64 years), demonstrated that telemedicine

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improved access, productivity, and continuity of care, while also helping reduce missed appointments and enabling home-based monitoring.

Finally, Avins et al. (2017) examined the relationship between telestroke and the administration of intravenous thrombolytics, particularly alteplase, in acute ischemic stroke. Conducted across 21 Kaiser Permanente Northern California stroke centers, the study implemented the Helsinki model and EXPRESS protocol, which integrate telemedicine into the early phases of stroke evaluation and management. These protocols emphasized prehospital notification, rapid neurological assessment, immediate CT imaging, and alteplase administration during scanning. The findings revealed substantial improvements in door-to-needle times and overall outcomes among patients treated within the first hour of stroke onset. Although further large-scale studies are needed to confirm these findings, the evidence suggests that telestroke, when combined with standardized treatment models, can significantly improve clinical efficiency and patient survival.

DISCUSSION

This section presents the key results, findings, and limitations drawn from the peer-reviewed studies reviewed for this research. The analyzed literature provides detailed insights into the role of telemedicine in stroke management, particularly in reducing door-to-needle times for acute ischemic stroke patients, facilitating teleneurology assessments during patient transport, identifying barriers to telestroke adoption, and evaluating telestroke networks and service utilization patterns.

Almeida et al. (2019) demonstrated that remote communication tools can play a significant role in managing acute stroke patients. Their study evaluated the JOIN Application, a cost-effective smartphone-based telemedicine system designed for rapid sharing of clinical and neuroimaging data to support decision-making in stroke management. Conducted at a comprehensive stroke center in Brazil between December 2014 and December 2015, the study analyzed 720 stroke codes, of which 422 were confirmed ischemic strokes. A multidisciplinary expert panel consisting of stroke neurologists and neuroradiologists reviewed each case using a standard Picture Archiving and Communication System (PACS) imaging workstation. The findings revealed that remote, application-based decision-making was as accurate as direct in-person evaluations by stroke specialists. Importantly, the implementation of the JOIN system led to a measurable reduction in door-to-needle times, underscoring the potential of mobile-based telemedicine to accelerate acute stroke treatment.

Audebert, Hubert, Müller-Barna, and Heinrich (2014) provided further evidence of the capacity of telemedicine to shorten prehospital delays and expedite stroke team activation. Their systematic review analyzed 25 studies—nine focusing on prehospital management, fourteen on stroke unit treatment, and two describing telestroke networks in developing countries—selected from an initial pool of 260 articles. The authors examined two German initiatives, the Mobile Stroke Unit (MSU) and Stroke Emergency Mobile (STEMO) projects, both of which demonstrated the feasibility of initiating intravenous thrombolysis (IVT) in the field prior to hospital arrival. These findings highlight how telemedicine can bridge the gap between prehospital and hospital care by making neurologists virtually available in ambulances. The authors emphasized that such models could be feasibly implemented in developing nations due to their cost-effectiveness and scalability.

Switzer et al. (2018) explored telestroke utilization patterns among Medicare fee-for-service beneficiaries in the United States from 2008 to 2015. Using administrative claims data from the Centers for Medicare and Medicaid Services (CMS), the study identified inpatients with a principal diagnosis of acute ischemic stroke (ICD-9-CM codes 433.x1, 434.x1, and 436). The results revealed that telestroke usage was more prevalent among younger male, non-Hispanic White, rural, and super-rural patients. Utilization rates were notably higher during the summer months, though the reason for this seasonal variation remains unclear.

Geographically, rural telestroke utilization was highest in Arizona (47.8 per 1,000 ischemic stroke cases), followed by South Carolina (36.7), Louisiana (13.9), Oregon (10.4), and Oklahoma (8.8). Among super-rural patients, the leading states were California (15.5), Utah (13.1), Oregon (12.0), Arizona (10.9), and Louisiana (10.0). Despite these encouraging trends, the authors noted that only about 55% of Americans have access to primary stroke centers within 60 minutes, and roughly half of those facilities lack an on-site neurologist. The

study concluded that the expansion of telestroke programs and networks is essential to bridge this gap, ensuring equitable, timely, and high-quality stroke care across underserved regions.

The Potential Implications of Telemedicine

As previously noted, beyond the audiovisual and teleradiology functionalities of telestroke, the technology has evolved to include integrated documentation systems that generate billable physician notes (Demaerschalk & Switzer, 2012). The authors observed that reliance on older communication methods, such as fax-based transmission of neuroimaging data, can delay critical decision-making during stroke emergencies. Their findings underscore that the unpredictable and time-sensitive nature of acute stroke necessitates robust and continuous information technology support to facilitate rapid diagnosis and treatment. Given that stroke onset demands immediate medical intervention, timely access to accurate imaging and expert consultation is crucial for improving clinical outcomes. Globally, behavioral and socioeconomic factors remain major contributors to stroke incidence. Benjamin et al. (2019) reported that approximately 74% of stroke cases are attributable to modifiable behavioral factors such as smoking, physical inactivity, and unhealthy dietary habits. Furthermore, the global burden of stroke disproportionately affects low- and middle-income countries, where limited healthcare infrastructure and resource constraints hinder effective prevention and management strategies.

In addressing long-term recovery, Barr et al. (2017) demonstrated that a telemedicine-based stroke coaching model is effective in improving post-stroke outcomes through better risk factor control, increased physical activity, improved diet, and enhanced medication adherence. However, the successful implementation of such models is dependent on patients having reliable access to mobile devices and internet connectivity—resources that are often unaffordable or unavailable in low-income settings. Despite these promising developments, the adoption of telestroke systems continues to face notable challenges. Key limitations include the potential risk of misdiagnosis due to technical or connectivity issues, data security and patient privacy concerns, and ongoing interoperability challenges between healthcare information systems. Addressing these barriers through standardized protocols, improved infrastructure, and equitable access to digital health technologies will be essential to fully realize the potential of telestroke in improving stroke care outcomes globally.

Strengths

Audebert and Hess (2013) described the progressive expansion of telehealth and its significant role in supporting both rural and community hospitals in the timely, safe, and effective management of acute stroke. The authors emphasized that the continued growth and optimization of telestroke services are crucial to fully harness the technology's potential benefits. Beyond acute interventions, they noted that telestroke systems can also be applied for specialist consultations and post-stroke follow-up programs, thereby extending care continuity beyond the acute phase. Importantly, the adoption of telestroke was found to be cost-effective from both hospital and societal perspectives, reflecting its value in improving healthcare access while reducing treatment delays and associated costs.

In a related study, Audebert and Müller-Barna (2012) explored the role of telestroke in reducing disparities in acute stroke care between specialized and non-specialized centers. They identified key components of telestroke systems, including remote neurological examinations conducted via videoconferencing, telephone-based information exchange networks, teleradiology services, and the electronic transmission of consultation summaries. The authors underscored that the effectiveness of telestroke programs depends heavily on the involvement of trained and experienced neurologists who can provide real-time decision support and guide local teams in evidence-based stroke management. Together, these studies highlight telestroke's dual role in enhancing access to specialized stroke expertise and standardizing care delivery across diverse healthcare settings, reinforcing its importance as a cornerstone of modern stroke management.

Limitations

There are significant legal and regulatory barriers to the adoption of telemedicine in the United States. Amar and Deths (2011) explain that the implementation of telemedicine within the healthcare industry is constrained by both regulatory and technical standards enforced by governmental and professional bodies. They propose

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the establishment of a centralized licensing system to facilitate interstate and international use of telemedicine across the United States. Licensing restrictions have notably limited its application in the treatment of various medical conditions. This challenge could be mitigated through the creation of a national or multistate telestroke license, which would enhance the efficiency and sustainability of telestroke networks (Demaerschalk & Switzer, 2012).

Furthermore, reimbursement issues arising from stringent regulatory policies discourage many stroke specialists from adopting telemedicine. Financial constraints, including the high initial capital cost and inadequate reimbursement mechanisms, represent major obstacles to widespread implementation. Technical challenges also impede the establishment of effective telestroke systems. For instance, disruptions in data transmission—such as those caused by switching between mobile networks during prehospital stroke management—can delay accurate diagnosis and timely intervention (Audebert, Hubert, & Muller-Barna, 2014).

Future Research

Telestroke remains underutilized and is still in the early stages of adoption (Randy & Rita, 2016). Further research is warranted to explore the expanding role of telemedicine in stroke management. It is anticipated that solutions addressing licensing flexibility, reimbursement challenges, and legal barriers will continue to evolve. In developing countries, telestroke offers a promising alternative for both acute and preventive stroke care. The shortage of neurologists, coupled with declining third-party reimbursements, is expected to drive the wider adoption of technology-enabled healthcare. The ongoing advancement of information and communication technologies in healthcare delivery holds significant potential to improve outcomes for patients while enhancing efficiency for providers and payers alike.

CONCLUSION

The telestroke coaching model has proven to be an effective approach for improving long-term outcomes and controlling stroke risk factors. However, more in-depth studies are needed to draw definitive conclusions. One of the reviewed studies implementing the telestroke coaching model required participants to have access to a mobile device. This poses a challenge in low-income settings, where owning a smartphone is often considered a luxury rather than a necessity, making participation unaffordable for many patients. Benjamin et al. (2019) reported that the global burden of stroke disproportionately affects low- and middle-income countries. Further research is needed to evaluate the long-term outcomes of stroke survivors enrolled in telestroke coaching programs, including the impact across various stroke etiologies. Although several reviewed peer-reviewed articles provided limited data, their findings suggest that telemedicine systems are feasible, acceptable, and reliable for acute stroke management. Early treatment of acute stroke patients with intravenous thrombolytics, particularly alteplase, was shown to improve patient outcomes. While the success of telestroke may in part be attributed to the use of alteplase, existing evidence remains insufficient to establish a definitive causal relationship (Avins et al., 2017).

The adoption of telehealth continues to expand across the U.S. healthcare system; however, several limitations hinder its full potential. Reimbursement challenges arising from stringent regulatory policies discourage healthcare providers from integrating these technologies. These regulations often lead to inconsistent reimbursement practices among payers. Sustaining and expanding telestroke networks will therefore require the development of strategies to overcome these regulatory and financial barriers. Establishing a national or multistate telestroke license, along with more flexible regulations, could significantly enhance the sustainability and effectiveness of telestroke systems (Demaerschalk & Switzer, 2012). Some studies also reported technical difficulties during telestroke consultations, which, although not detrimental to outcomes, highlighted potential risks of delays in information exchange. Overall, telestroke remains underutilized and is still in the early stages of adoption (Audebert, Hubert, & Muller-Barna, 2016). Future research should focus on addressing licensing flexibility and resolving technical challenges to strengthen the reliability and accessibility of telestroke services.

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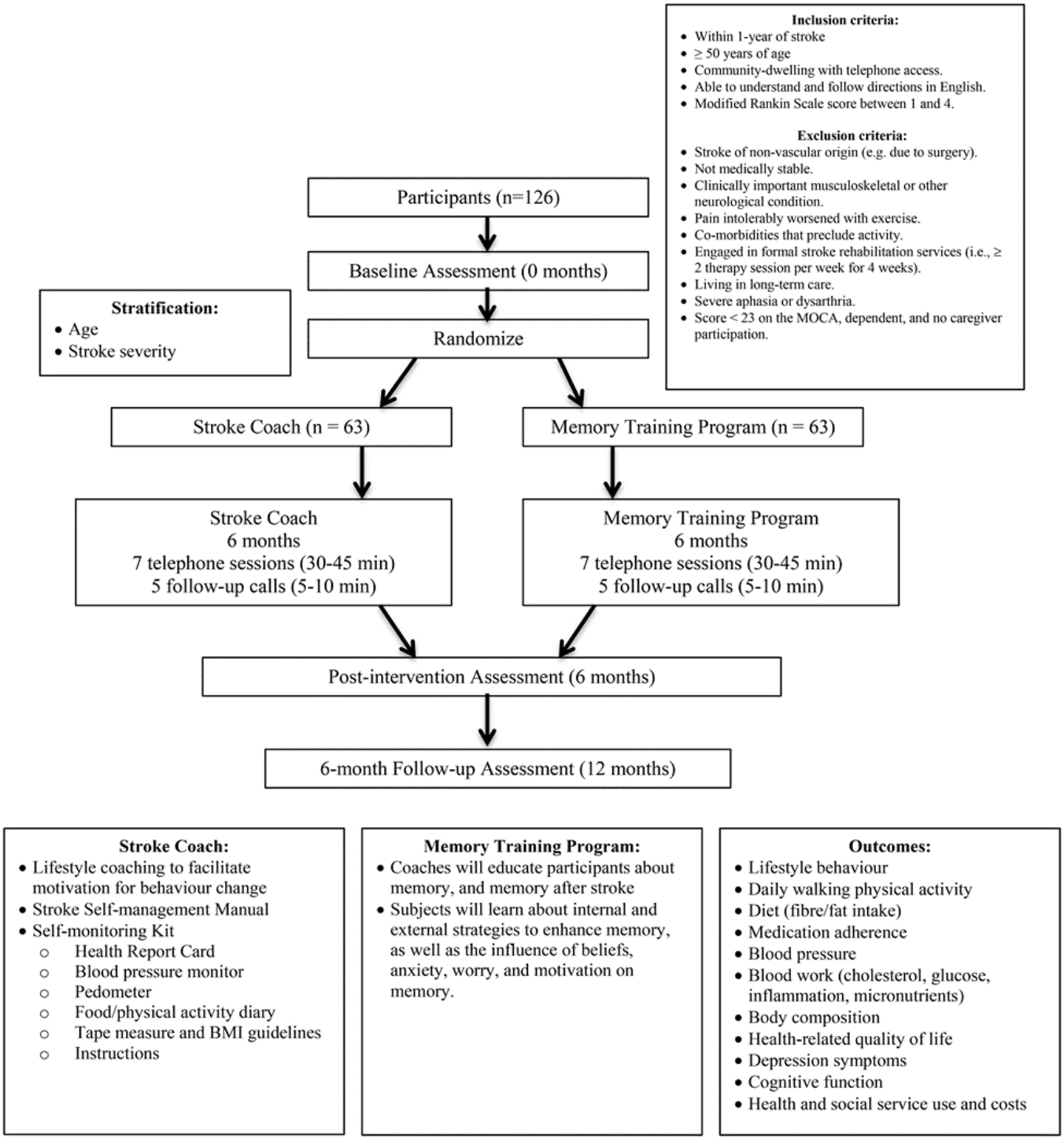
APPENDIX

Appendix A

Figure 1. A Detailed Overview of Telestroke Coach Model



Appendix B

Figure 2. Overall Agreement and Disagreement Findings between Telemedicine Vascular Neurologist and Onboard Vascular Neurologist

IV tPA Agreement Between Telemedicine Vascular Neurologist and Onboard Vascular Neurologist			
κ (95% CI)	Positive agreement, %	Negative agreement, %	Overall raw agreement, %
0.73 (0.62–0.84)	90.6	82.5	87.7
Agreement of hemorrhage on CTH between telemedicine vascular neurologist and onboard vascular neurologist			
κ (95% CI)			
0.97 (0.92–1.00)			
NIHSS agreement between telemedicine vascular neurologist and onboard vascular neurologist			
Intraclass correlation (95% CI)	For raw NIHSS		
0.88 (0.84–0.91)			
Weighted κ (95% CI)	For NIHSS groups (0–5, 6–12, and >13)		
0.71 (0.62–0.79)			
IV tPA decision time metrics between telemedicine vascular neurologist and onboard vascular neurologist (MSU arrival to decision)			
	Mean (min)	Median (min)	25th to 75th %tile (min)
Telemedicine vascular neurologist	35.8	32	25–41
Onboard vascular neurologist	18.8	18	14–23
Reasons for tPA disagreement between telemedicine vascular neurologist and onboard vascular neurologist (n=20)			
Minor/nondisabling symptoms	7		
Seizure at onset	2		
Concerns for subdural hematoma on CTH	2		
History of intracranial hemorrhage	1		
Elevated glucose and uncontrolled HTN	1		
Recent tPA within past 3 mo	1		
Current use of anticoagulation	1		
Concern for ischemic limb	1		
Concern for cerebral aneurysm on CTH	1		
Concern for degree of hypodensity on CTH	1		
Laboratory value: PT=16.5	1		
Concern for chest pain that require CXR before treatment	1		

CI indicates confidence interval; CTH, computed tomography of head; CXR, chest radiography; HTN, hypertension; IV, intravenous; NIHSS, National Institutes of Health Stroke Scale; PT, prothrombin time; and tPA, tissue-type plasminogen activator.

Appendix C

Figure 3 Demographic and Risk Factors of Stroke

	Total Patients (N=174)
Age, mean (SD), y	66.5 (16.7)
Male sex, n (%)	89 (51.1)
NIHSS score*, median (IQR)	11 (13)
Stroke risk factors	
Stroke/TIA, n (%)	69 (39.7)
Cardiac arrhythmias, n (%)	30 (17.2)
Hypertension, n (%)	139 (79.9)
Coronary artery disease, n (%)	19 (10.9)
Diabetes mellitus, n (%)	57 (32.8)
Hyperlipidemia, n (%)	64 (36.8)
Current smoker, n (%)	40 (23.0)
IV tPA administered, n (%)	116 (66.7)

IQR indicates interquartile range; IV tPA, intravenous tissue-type plasminogen activator; NIHSS, National Institutes of Health Stroke Scale; and TIA, transient ischemic attack

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Appendix D

Figure 4. Review of Articles Selected for the Study Conducted by Audebert, Hubert, and Muller-Barna