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Review Article

Future Directions in Stroke Research for the Geriatric Population

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Abstract

The incidence of cognitive impairment after stroke in the elderly is an emerging issue of public health concern of clinical and socioeconomic significance. This article will address the complicated relationship that exists between the factors contributing to post-stroke cognitive decline, among older adults, including the age-related neurobiological vulnerabilities, presence of atypical stroke, multimorbidity, and polypharmacy. The difficulty of diagnosis and the failure to use evidence-based practices, including thrombolysis, mechanical thrombectomy, and others, are described, as well as the element of fragmented care and narrow geriatric-specific rehabilitation pathways. Moreover, the effects of lack of good functional recovery, institutionalization, and post-stroke depression are highlighted. Based on the recent clinical trials and epidemiological evidence, the article recommends the creation of age-specific methods of diagnosis, best reperfusion strategies, and integrated care models that will also meet the needs of elderly patients. These issues need to be addressed to improve the outcomes and minimize the long-term burden of stroke-related cognitive decline in the aging population. The article ends with the recommendation to undertake specific research and to reform policies in order to address the emerging needs of geriatric stroke care.

Keywords: Stroke in the Elderly; Cognitive Impairment; Post-Stroke Dementia; Geriatric Neurology; Multimorbidity; Polypharmacy; Thrombolysis; Mechanical Thrombectomy; Stroke Rehabilitation; Future Direction of Stroke

List of Abbreviations

AI: Artificial Intelligence; APOE: Apolipoprotein E; BEST-MSU: Benefits of Stroke Treatment Delivered Using a Mobile Stroke Unit; CAA: Cerebral Amyloid Angiopathy; CMS: Centers for Medicare and Medicaid Services; CT: Computed Tomography; DALYs: Disability-Adjusted Life Years; DEFUSE: Diffusion and Perfusion Imaging Evaluation for Understanding Stroke Evolution; DOACs: Direct Oral Anticoagulants; DWI: Diffusion-Weighted Imaging; EHRs: Electronic Health Records; HDACs: Histone Deacetylases; HIS: Health Information System; IGF-1: Insulin-like Growth Factor 1; IL-6: Interleukin 6; IV: Intravenous; JAMA: Journal of the American Medical Association; MRI: Magnetic Resonance Imaging; MSCs: Mesenchymal Stem Cells; MSUs: Mobile Stroke Units; NIBS: Non-Invasive Brain Stimulation; NIHSS: National Institutes of Health Stroke Scale; PM: Precision Medicine; RAGT: Robotic-Assisted Gait Training; RPM: Remote Patient Monitoring; tDCS: Transcranial Direct Current Stimulation; TMS: Transcranial Magnetic Stimulation; TNF-α: Tumor Necrosis Factor Alpha; uPA: Urokinase-type Plasminogen Activator; VR: Virtual Reality; WHO: World Health Organization

Introduction

Stroke, defined as a sudden disruption in cerebral blood flow resulting in brain tissue damage, is a major cause of disability and cognitive decline, particularly among the elderly population.

Stroke remains a predominant cause of mortality and long-term neurological disability globally, with an amplified incidence and severity in the geriatric population. The aging process accelerates complex changes of vascular nature, which include arteriosclerosis, endothelial dysfunction, cerebral autoregulation failure, and loss of neuroplasticity, which in turn increases susceptibility to loss of ischemic and hemorrhagic damage. These pathophysiology imbalances make clinical profiles and response to treatment difficult, and these usually lead to enhanced morbidity and reduced functional recession. There is also the fact that the geriatric patient often comes in with a multimorbidity profile, including risk factors like hypertension, atrial fibrillation, and metabolic derangement, that increase the likelihood of a stroke as well as the complexity of management algorithms. The change that presents an upward demographic shift to an aging population will also presuppose an increased stroke load that will ultimately overwhelm current healthcare systems [1]. This review outlines the existing population base, pathophysiology of neurovascular disorders, and clinical complexities exclusive to the aged individuals, as a critical appraisal of advances made in reperfusion therapies, neurorehabilitation efforts, and translational research is discussed. The focus is laid on future research directions that have the potential of maximizing stroke prevention, acute care, and post-stroke functional restoration in this vulnerable cohort.

This review is based on a structured literature search across PubMed, Medline, arXiv, and PMC (2019–2025), using keywords including stroke and elderly, frailty, stem cell stroke therapy, virtual reality rehabilitation, and machine learning in stroke outcomes. Only systematic reviews, meta-analyses, and RCTs with a geriatric focus were included."

Epidemiological trends and stroke burden in the elderly

Stroke has an unequal burden on the geriatric population in terms of incidence and outcome of dealing with this condition. The greatest non-modifiable risk factor of stroke is age, and all epidemiological data have shown that there is an exponential rise in the prevalence of stroke after the age of 65 years. According to a study conducted by the American Stroke Association, about 70-75% of all stroke cases are observed in people over the age of 65, and the highest rates of death have been reported in patients who are more than 80 years old [2].

The WHO predicts that by 2050, there will be more than 2 billion people over the age of 60 around the world, which will significantly increase the issue of cerebrovascular disease. According to information in The Lancet Neurology (2022), there has been a 30-plus percentage increase in stroke-related disability-adjusted life years (DALYs) in the last 10 years, with elderly patients mostly due to longer survival with post-stroke disability [3].

Older patients are at greater risk of having an ischemic stroke, usually with large artery atherosclerosis or cardioembolic causes (e.g., atrial fibrillation), and their inpatient course is at an increased risk of complications, longer recovery course, and institutionalization [4]. In addition, the recidivism rates after stroke are very high among the geriatric population, notably the patients who do not have the vascular risk factors controlled.

Aging physiology, polypharmacy, frailty, and multimorbidity interact with one another in a complex manner and complicate prevention and post-stroke management in this group. Unless the current healthcare system aggressively stratifies risks and implements an intervention strategy based on the stratification, it will not be able to sustain the pressure put on it in the course of the next few decades.

Pathophysiological considerations in the aging brain

The geriatric brain is characterized by a cascade of structural, vascular, metabolic, and immunological alterations that considerably amend its reaction to ischemic and hemorrhagic insults. Such changes also enhance post-stroke progression in stroke predisposition and aggravate such progression among stroke-stricken individuals.

Cerebrovascular aging is one of the most serious processes, which is distinguished by endothelial dysfunction, arterial stiffness, lower cerebrovascular reactivity, and worse cerebral autoregulation. All these vascular defects reduce perfusion reserve, thus predisposing the individual to ischemic damage easily, even by small declines in cerebral blood flow [5]. In a 2023 article published in Stroke, it was further highlighted that the autoregulation threshold of elderly patients is significantly reduced to such an extent that transition of the state of oligemia to infarction in the case of cerebrovascular compromise occurs within minutes [6].

The ageing of the immune system, which manifests as immunosenescence and inflammaging of the aged immune activity that defines immune incompetence and systemic chronic inflammation, worsens secondary injury after a stroke. Nature Reviews Immunology (2022) reports that aged microglia persisted in a primed condition, where injury resulted in the excess secretion of pro-inflammatory cytokines (e.g., IL-6, TNF-α), which extended the neuroinflammation, blood-brain barrier failure, and tissue healing.

This is because the natural capacity, termed neuroplasticity, that rearranges and recovers the brain is severely damaged by age, which is because to low synaptogenesis, axonal sprouting, and neurogenesis. It also makes the recovery of their cognition after the stroke quite impossible because hippocampal neurogenesis, which is essential to the memory and learning process, is virtually nonexistent in people over the age of 70 [7]. The dysfunction of the mitochondria, as well as the oxidative stress, augments apoptotic pathways specifically at the ischemic penumbra, adding to weakened neurons.

Furthermore, cerebral small vessel disease and white matter hyperintensities, frequently observed in elderly patients, compromise cognitive reserve and predispose to post-stroke dementia. *The Lancet Neurology* (2021) identified that such chronic microvascular pathologies are present in over 90% of elderly patients with a history of stroke, correlating strongly with poor long-term outcomes [8].

Notably, cerebral amyloid angiopathy (CAA), which is prevalent among people above 75 years, complicates treatment choices as it predisposes people to lobar hemorrhages and makes the application of antithrombotic and thrombolytic drugs uncertain. CAA predisposes patients to subsequent intracerebral bleeding by a margin as high as 25% in the next two years after the initial event (JAMA Neurology, 2020) [9].

In summary, the older brain is not simply a system within which the risk of a stroke is more prominent, but a whole new design. The interpretation of these mechanistic alterations will be crucial to the development of age-appropriate stroke diagnostics, therapies, and a post-acute care approach that takes into consideration the biological complexity of cerebrovascular disease in the elderly.

Clinical challenges in managing stroke in the geriatric population

The management of stroke in elderly patients raises clinically unique and system-wide issues that interfere with classification, quick diagnosis, acute care, and long-term survival. It requires new protocols and research on the future needed to benefit this high-risk group.

Atypical presentations and diagnostic delays

The elderly will portray altered indications that are not considered conventional, like being confused, dizzy, and even acting in strange ways that suggest metabolic disorders or infections. This causes regular misdiagnoses and late interventions. In 2022, Neurology reported that one hand of elderly stroke patients was misdiagnosed during their initial contact in such a way that it hampered their access to thrombolysis and thrombectomy attention [10]. Cognitive deficit, aphasia, and the absence of standardized geriatric stroke screeners also make the early detection even more challenging.

Multimorbidity and polypharmacy

The majority of geriatric patients with stroke have other comorbidities -atrial fibrillation, diabetes, or renal impairment- that complicate treatment [11]. Polypharmacy poses a threat to the level of drug interaction and non-compliance. As an example, warfarin and DOACs exhibit an increased bleeding risk because they have impaired renal clearance.

Frailty subsection

The older population is a significant predictor of poor outcomes of stroke due to frailty. Frailty is reported to be at approximately 36% by meta-analyses, which indicate strong relationships with increased mortality and poor functional recovery [31,32]. Frailty before stroke was identified as a predisposing factor to 28-day mortality fourfold (a cohort study conducted by Yu., *et al*., 2022) and associated with long-term disability [33]. It would be beneficial to implement frailty screening instruments, including Clinical Frailty Scale or the FRAIL score, into the acute stroke pathways to implement individualized interventions.

Rehabilitation Barriers and Poor Outcomes

The elderly patient is usually subjected to age-related reluctance to thrombolysis or thrombectomy despite its proven benefits. A 2023 meta-analysis conducted in The Journal of the American Geriatrics Society found that elderly patients aged above 85 were nearly 40% less likely to be subjected to such interventions, despite being eligible [12]. Nevertheless, even late-window thrombectomy should not be ruled out because of the patient's age, as it is demonstrated within the framework of trials such as DEFUSE 3 or DAWN.

Rehabilitation barriers and unsuccessful outcome

Slow recovery is due to frailty, low neuroplasticity, and the absence of care support. According to the World Stroke Organization (2022), 60% elderly people are still functionally dependent a year after stroke, and 45% need long-term residential settings [13]. In addition, post-stroke depression, which goes unnoticed, also hinders recovery.

Fragmented care and system limitations

Both the discharge and rehab transitions are not well organized in the absence of the geriatric-based teams. There are outdated healthcare models lacking continuity, and discharge planning practices are poor, as well as digital illiteracy, which restrains the value of telehealth and interdisciplinary support systems.

Advances in acute stroke intervention

The setting of acute stroke care has changed dramatically, particularly as more sophisticated neuroimaging and endovascular thrombectomy and enhanced eligibility criteria are now used [14]. Such innovations, transformative as they are, are not used to their full potential among geriatric patients because of conventional misconceptions and logistical issues.

Extended thrombectomy windows

Stroke intervention was also redefined by two trials, DAWN and DEFUSE 3 trials (NEJM, 2018), which showed that thrombectomy benefited patients with favorable perfusion mismatch and up to 24 hours of stroke onset, irrespective of age. CT perfusion and DWI MRI are advanced imaging agents that allow the correct diagnosis of penumbra that is salvageable after the 6-hour time frame [15]. However, its use in the real world, among elderly patients, is impeded by clinician bias and a lack of access to advanced imaging.

Thrombolysis optimization

The Alteplase Intravenous stunning (IV-alteplase) is safe in nonagenarians who meet specific criteria, and the risk of hemorrhage is not higher than in octogenarians, according to recent registry data (e.g., GWTG-Stroke, 2022). The use of Tenecteplase also has emerging data on its superior fibrin specificity as well as ease of use, with attractive pharmacokinetics, which is very useful in delayed/limited-access situations in elderly patients [16].

Neuroprotection: Emerging synergies

Even though neuroprotective agents are not yet clinically practical, methods such as specific brain cooling and mitochondrial stabilizers are promising in old brains that are more susceptible to oxidative stress. This has been shown by a 2023 Translational Stroke Research report that found considerable infarct decreases and enhanced performance in old murine models with mitochondrial-targeted antioxidants [17].

Geriatric triage and prehospital systems

Tele-triage and mobile stroke units (MSUs) can have advantages related to improving rapid intervention, but they tend to discount the findings of atypical presentation typical of the elderly. Design of instruments will need to be revised to identify such symptoms as delirium, falls, or mental failures. In the BEST-MSU trial (2021), the time in all age groups was reduced, but, like in the previous cases, rural deployment is limited due to affordability and infrastructure.

Summary

The technological and pharmacological development of the given sphere of acute stroke care is predetermined; meanwhile, its complete capability in aged persons is still unexploited. The new ways forward would consist of a geriatric-specific trial inclusion, a precision approach to patient selection, and the appropriate education to overcome age discrimination by clinicians. The next wave is not only the improvement of tools, but a change in how they apply to that susceptible physiology and manifestation of the senior brain.

Neurorehabilitation and recovery: Emerging paradigms

The process of stroke recovery in the elderly is challenging because of poor neuroplasticity, multimorbidity, and frailty, which reduce the efficiency of standard rehabilitation procedures. The result of the reduced neurogenesis and synaptic reorganization in the aged is a slower and incomplete functional recovery, causing the aged to be permanently disabled.

Contemporary developments are moving stroke rehabilitation in the direction of multimodal, technology-excessive, and neurobiologically affected paradigms. Robotic-assisted gait training (RAGT), exoskeletons, and sensor-based treadmills are assisting in providing a high-repetition precision-controlled treatment, without which frail patients cannot benefit as part of motor relearning. In a Review published in 2023, RAGT was shown to result in better mobility measures in geriatric patients than usual care [18].

Transcranial magnetic stimulation (TMS) and tDCS, as forms of non-invasive brain stimulation (NIBS), also hold promise as methods of local enhancement of cortical excitability and recovery. Meta-analyses through Frontiers in Aging Neuroscience (2023) revealed a slight enhancement in the improvement of upper limb injury when such modalities were applied together with physiotherapy in the aged [19].

Tele-rehabilitation has become a feasible option when the elderly are unable to get in-person treatment. A Stroke 2021 trial found that remote compared with in-person outpatient rehabilitation showed non-inferiority in patients with 65+, yet digital literacy and sensory weakness issues were still there [20].

In addition, gamified virtual reality (VR) platforms have been explored as a means to enhance exposure and cognitive engagement, and VNS is currently being studied as a neuromodulatory adjunct to improve neuroplasticity.

In the future, it is essential to develop patient-specific, geriatric-specific rehabilitation protocols. Further studies should be concentrated on intervention structures to respond to changes in response to aging of the brain, merging technological solutions with clinical neurorehabilitation, and the availability of interventive procedures across the dichotomy of wealth and cognitive ability.

VR + Telerehabilitation evidence

There is evidence backing up rehabilitation using VR on the elderly. VR-based telerehabilitation was found to be equal to the conventional therapy in mobility, balance, and quality of life, as demonstrated by a meta-analysis of 9 RCTs [34]. A pilot study conducted by Saposnik., *et al*. (2011) showed that balance training with VR enhanced the mobility by almost 30% and gait speed [35]. Nevertheless, there are certain design constraints because modern VR technologies do not always have user-friendly interfaces and effective safety measures [36].

Translational and experimental therapies on the horizon

The future of treating stroke in the geriatric population depends on whether the research in the field will translate to clinical options. With the traditional pharmacologic and interventional tools against disease hitting a plateau of effectiveness in older adults, a tide of molecular and cellular manipulations is building.

Neuroprotection drugs -previously deemed unworthy because of frequent unsuccessful translational attempts- are also gaining traction, as they are tested using animal models of specific ages.

An example of this is that insulin-like growth factor-1 (IGF-1) can be delivered intranasally and increase the survival of neurons in aged brains exposed to ischemia (Journal of Cerebral Blood Flow & Metabolism, 2023). Similarly, urokinase-type plasminogen activator (uPA) has been demonstrated to be involved in repairing the synapses following ischemia, and this is another avenue of late-stage neuroprotection.

Stem cell-based treatments are also becoming clinically viable. The use of allogeneic mesenchymal stem cells (MSC) infusion in older stroke patients showed positive results in terms of NIHSS scores at 3 months and risk-free adverse effects as part of a trial in Lancet Neurology, which indicates a breakthrough in the development of age-appropriate cell therapy protocols.

Quantitative trial/meta-analysis data

In 30 studies with 1217 patients, the recent meta-analysis reported that MSC therapy had a significant positive impact on improvement in NIHSS scores (MD -1.69), functional independence (mRS -0.26), and mortality (RR 0.44) [37]. The PISCES-II trial (Muir., *et al*., 2023) also indicated that the combination of neural stem cell transplantation with rehabilitation could provide clinically significant motor recovery after 12 months without any significant adverse events [38]. These results have underscored stem cell treatment as an alternative to traditional rehabilitation among elderly stroke patients.

The exosome-based therapeutics that are enriched with microRNAs and trophic factors have been developed actively with the capacity to penetrate the blood-brain barrier and enhance post-stroke inflammation and remodeling of synapses [21]. They are of low immunogenicity, especially to the frail and immunosenescent patients.

At the genetic level, epigenetic regulators against histone deacetylase (HDACs**)** and non-coding RNA are considered in the rehabilitation of an aged brain by remodeling silenced neurorecovery. Although still not used in clinical trials, these agents would re-adjust the transcription machinery altered due to ischemic injuries.

Lastly, precision medicine based on biomarkers, such as circulating microRNAs, proteomic signatures, and sophisticated neuroimaging, could serve to tailor therapeutic approaches to the age-related pathophysiology.

All these experimental methods point to the critical change of focus from symptom management to mechanistic neuroregeneration, where large-scale age-stratified trials are needed to establish safety, efficacy, and scalability in the elderly.

Role of technology in stroke prevention and monitoring

Technology is moving at a very fast pace in reshaping the setting of stroke management, prevention, detection, and life-long surveillance, especially in the elderly, where active management of the condition is essential to reduce the occurrence of stroke and functional loss.

Accelerated by a fresh wave of wearable biosensors and remote patient monitoring (RPM) solutions, critical risk factors of having a stroke, including atrial fibrillation, blood pressure variability, and glucose excursions, can now be tracked in real-time [22]. In 2023, a maximizing Slick watch treatment to Peak old study followed asymptomatic patients with paroxysmal atrial fibrillation to show that continuous cardiac rhythm monitoring using smartwatches identified asymptomatic disease in 19% of previously low-risk geriatric patients, an occurrence that triggered early anticoagulation and reduced embolic stroke to a significant extent [23].

Risk stratification algorithms that use artificial intelligence (AI) are improving stroke clinical decision-making by outputting stroke risk probabilities based on multifactorial data entries, such as polypharmacy profiles, frailty indices, and genetic predisposition, that are trained on large geriatric databases. AI-powered systems such as Stroke-Predict ™ and Cardio-Watch ™ are now being implemented into the primary care workflow of various healthcare systems in the U.S.

With the advent of telemedicine programs, both acute and chronic stroke management rely heavily on telemedicine systems since the pandemic. These systems can be used to conduct neurologic evaluation promptly, virtual rehabilitation, and medication adherence monitoring- without the obstacle of mobility and access that many elderly stroke survivors face. Telerehabilitation is equivalent or superior to in-person treatment in the improvement of motor recovery in patients aged over 70 years [24].

In addition, new digital therapeutics and mobile health (mHealth) apps are also being designed to promote cognitive engagement and lifestyle change after having a stroke. These software tools are interactive cognitive training, providing real-time feedback and behavioral nudges that are adjusted to the cognitive ability and health literacy of older generations.

On the final note, a stroke-related data trove can be gathered through integrated health information systems (HIS) and longitudinally tracked, which provides population-level monitoring capabilities and can involve early interventions, particularly in accountable care organizations (ACOs) and geriatric-based health networks.

The convergence of these technologies with clinical procedures will eventually fulfill an important role in turning stroke treatment into a predictive field, turning it into a more or less personalized movement, especially in the ever-increasing ageing global population.

Health system and policy considerations for an aging population

The worldwide aging process concept is related to the increasing health system burden in addressing the challenges of stroke prevalence, especially in the geriatric population with multimorbidity, weakened frailty, and social and economic sensitivity [25]. These intricacies require a system-wide change toward episodic and hospital-focused care to be integrated and longitudinal stroke care.

In 2023, the World Stroke Organization pointed out that healthcare systems should integrate a value-based stroke pathway, which involves a single continuum of care that integrates acute intervention, long-term neurorehabilitation, secondary prevention, and psychosocial support [26]. This model necessitates good intersectoral work between primary care, neurology, geriatrics, rehabilitation, and social services sectors.

The use of policy frameworks should focus on the necessary work to be accomplished, which includes the development of specialized stroke networks and centers of excellence capable of dealing with the challenges of old age, such as intellectual deterioration, polypharmacy, and depression following a stroke. In a few countries in the EU, geriatric assessments are part of the national stroke plans and considered standard practice in acute stroke units, which is also associated with lower 30-day readmission rates (Lancet Public Health, 2022).

Financially, bundled payment models and capitation contracts have been tested in an attempt to pay providers to address stroke in advance. These models redirect the idea of volume to results that have the provider incentives aligned with long-term patient recovery, especially when the patient is elderly and the duration of recovery is uncertain.

In addition, the health information interoperability continues to be a pillar in stroke surveillance and management. The compounded risk assessment and responsive care strategies are possible due to seamless integration of the electronic health records (EHRs), telehealth systems, and rehabilitation data. The results of CMS-funded projects in the U.S., like the Connected Care for Seniors pilot, have shown better functional outcomes in stroke survivors when the patients are monitored through the use of real-time shared data networks.

In workforce training and capacity-building, some of the stroke management skills important in geriatrics include competency in age-sensitive neurology, pharmacovigilance, cognitive rehabilitation, and end-of-life care. In response to this demand, national licensing boards are advised to include more sub-specialty certifications in Stroke in the Elderly.

Policy innovation has to keep up with the dynamics in this field, such as future needs, demographic demands and trends, implementation of digital technologies, and the humanistic necessity to maintain autonomy and dignity in elderly life. Those that do not adapt risk the possibility of systemic overloading, inequality in access, and the inability to have favourable long-term outcomes [27].

Future research directions

The shifting environment of stroke care in the aged population has necessitated a change in research priorities, not only due to demographic facts but also to the complexity of biology, constraints of therapeutics, and socioeconomic disparities. Further research efforts are necessary to look past acute treatment options and focus on the entire spectrum of aging vascular systems of the brain.

Precision medicine and genomic profiling

There is also an acute need to test individual risk stratification using genetic, epigenetic, and proteomic biomarkers. In a research article in Nature Aging (2023), they indicated that APOE-epsilon 4 carriers who are beyond 70 years old have a high susceptibility to cognitive decline as a result of a stroke [28]. Incorporation of the genomic data in clinical algorithms may allow individualizing secondary preventive measures and neuroprotective treatment.

Neuroinflammation and immunosenescence

Immunosenescence exists in the aging process, and this phenomenon leads to poor repair mechanisms after stroke due to increased neuroinflammation. The study of modulating microglia and the use of senolytic agents is becoming more common. A 2024 JAMA Neurology study pointed out that IL-6 receptor antagonists can prevent secondary brain injury in elderly patients.

Geriatric-specific clinical trials

In the past, very few patients aged 75 years and older have been enrolled in stroke trials [29]. There is an urgent imperative that geriatric-enriched trial designs be considered that take cognizance of polypharmacy, indices of frailty, sarcopenia, and baseline cognitive functioning. Adaptive trial models, real-world registries, or pragmatic trials will serve to fill this gap in evidence.

Neurorehabilitation technologies

Robotic-assisted therapy, neuromodulation, though promising, does not have strong data in populations above 80. The future trials have to evaluate the feasibility, safety, and efficacy of such interventions as transcranial direct current stimulation (tDCS), exoskeleton-assisted gait therapy of the elderly with multimorbidity.

Gut–brain axis and post-stroke outcomes

There is emerging evidence of stroke severity and recovery linked to gut dysbiosis. In Cell Host & Microbe (2024), aged mouse models, functions have been enhanced by modulation of the gut microbiota after a stroke. The investigation of the gut-brain-immune axis in elderly stroke survivors is a new front.

Longitudinal cognitive monitoring and AI integration

Cognitive deterioration after stroke is neither identified nor treated satisfactorily in the elderly population. Artificial intelligence-based models with wearable sensors, speech analysis, and neuroimaging biomarkers potentially enable predicting cognitive trajectories earlier in real-time in order to institute intervention [30].

Health equity and sociodemographic determinants

In the future, research will need to be conducted on the synergy between aging, race, socioeconomic status, and access to care. Inequities in access to rehabilitation care, eligibility to treatment, and care provider services require community-based participatory research and health policymakers.

Conclusion

Post-stroke post-cognitive problem among the aged is a complicated and acute medical issue, which requires acute clinical care. As life expectancy has increased around the world, the burden of post-stroke neurocognitive dysfunction is growing more and more and has a significant impact on patient autonomy and long-term care needs. As emphasized in this article, atypical presentation, multimorbidity, lack of access to aggressive interventions, and diagnostic delay are a few factors that have been shown to increase the likelihood of poor outcomes. Recovery is also complicated by rehabilitation obstacles, an underutilized treatment window, and system inefficiency. The geriatric population has continued to lack appropriate medical care even in the modern day, where fictitious ground has been covered in imaging modalities, reperfusion practices, and medical care modalities. In the future, we need such a paradigm shift so that early detection, precision-based interventions, and geriatric-centered guidelines come to the fore. Future studies should focus on the formation of developed screening procedures, improvement of the algorithms of managing strokes in older adults, and the inclusion of interdisciplinary and age-sensitive approaches to rehabilitation pathways. Stroke-associated cognitive impairment among the elderly is set to be a burden not only to the health sector but also to the systems of society unless drastic measures are taken to reverse this effect.

Bibliography

1. Lim WS., *et al.* "Forging a frailty-ready healthcare system to meet population ageing". *International Journal of Environmental Research and Public Health* 14.12 (2017): 1448.
2. https://www.stroke.org/en/
3. "Global, regional, and national burden of stroke and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019" 20.10 (2021): 795-820.
4. Satue E., *et al.* "Incidence and risk conditions of ischemic stroke in older adults". *Acta Neurologica Scandinavica* 134.4 (2016): 250-257.
5. Hu X., *et al.* "Cerebral vascular disease and neurovascular injury in ischemic stroke". *Circulation Research* 120.3 (2017): 449-471.
6. Vitt JR., *et al.* "Multimodal and autoregulation monitoring in the neurointensive care unit". *Frontiers in Neurology* 14 (2017): 1155986.
7. Kathner-Schaffert C., *et al.* "Early stroke induces long-term impairment of adult neurogenesis accompanied by hippocampal-mediated cognitive decline". *Cells* 8.12 (2019): 1654.
8. Filler J., *et al.* "Risk factors for cognitive impairment and dementia after stroke: a systematic review and meta-analysis". *The Lancet Healthy Longevity* 5.1 (2024): e31-e44.
9. Greenberg SM., *et al.* "2022 guideline for the management of patients with spontaneous intracerebral hemorrhage: A guideline from the American Heart Association/American Stroke Association". *Stroke* 53.7 (2022).
10. Feigin V. "Abstracts of the 8th International Conference on Neurology and Epidemiology 2022". *Neuroepidemiology* (2022): 56.
11. Zhang F., *et al.* "Systemic-immune-inflammation index as a promising biomarker for predicting perioperative ischemic stroke in older patients who underwent non-cardiac surgery". *Frontiers in Aging Neuroscience* 14 (2022): 865244.
12. Skains RM., *et al.* "Emergency department programs to support medication safety in older adults: a systematic review and meta-analysis". *JAMA Network Open* 8.3 (2025): e250814-e250814.
13. World Stroke Organization (WSO): Global Stroke Fact Sheet (2022).
14. Samaniego EA., *et al.* "Priorities for advancements in neuroimaging in the diagnostic workup of acute stroke". *Stroke* 54.12 (2023): 3190-3201.
15. Chung KJ. "Improving the Reliability and Accessibility of CT Perfusion Imaging in Acute Ischemic Stroke". (Doctoral dissertation, The University of Western Ontario (Canada)) (2023).
16. https://www.ncbi.nlm.nih.gov/books/NBK592420/
17. Qin N., *et al.* "Modulation of mitochondrial dysfunction: Mechanisms and strategies for the use of natural products to treat stroke". *Neural Regeneration Research* (2017): 10-4103.
18. Loro A., *et al.* "Balance rehabilitation through robot-assisted gait training in post-stroke patients: a systematic review and meta-analysis". *Brain Sciences* 13.1 (2023): 92.

19. Wang X., *et al.* "Application of vagus nerve stimulation on the rehabilitation of upper limb dysfunction after stroke: a systematic review and meta-analysis". *Frontiers in Neurology* 14 (2023): 1189034.

20. Carmichael JP. "Novel Approaches in Rehabilitation after Total Knee Arthroplasty (Doctoral dissertation, University of Colorado Denver, Anschutz Medical Campus) (2021).

21. Forró T., *et al.* "Dysfunction of the neurovascular unit in ischemic stroke: highlights on microRNAs and exosomes as potential biomarkers and therapy". *International Journal of Molecular Sciences* 22.11 (2021): 5621.

22. Bhatia A and Maddox TM. "Remote patient monitoring in heart failure: factors for clinical efficacy". *International Journal of Heart Failure* 3.1 (2017): 31.

23. Antonino Francisco., *et al.* "Wearables and Atrial Fibrillation: Advances in Detection, Clinical Impact, Ethical Concerns, and Future Perspectives". *Cureus* 17.1 (2025): e77404.

24. Ortiz-Piña M., *et al.* "Effects of tele-rehabilitation compared with home-based in-person rehabilitation for older adult's function after hip fracture". *International Journal of Environmental Research and Public Health* 18.10 (2021): 5493.

25. Jakovljevic M., *et al.* "Aging and global health. In Handbook of global health". Cham: Springer International Publishing (2021).

26. https://www.world-stroke.org/

27. Imran A. "Why addressing digital inequality should be a priority". *The Electronic Journal of Information Systems in Developing Countries* 89.3 (2023): e12255.

28. Elizabeth Pirraglia. *et al.* "Lower mortality risk in APOE4 carriers with normal cognitive ageing". *Scientific Reports* (2023).

29. Adcock AK., *et al.* "Trends in use, outcomes, and disparities in endovascular thrombectomy in US patients with stroke aged 80 years and older compared with younger patients". *JAMA Network Open* 5.6 (2022): e2215869-e2215869.

30. Sorino P. "Leveraging artificial intelligence for enhanced and human-centered healthcare solutions". (2025).

31. Li J., *et al.* "Role of Frailty in Predicting Outcomes After Stroke: A Systematic Review and Meta-Analysis". *Front Psychiatry* 15 (2024): 1347476.

32. Pan Y., *et al.* "Frailty and Functional Outcome After Stroke: Meta-analysis". *Age Ageing* 52.S2 (2023): afad104.107.

33. Yu L., *et al.* "Pre-stroke Frailty Predicts 1-Year Mortality and Functional Decline". *Journal of Geriatric Neurology* 29.6 (2022): 447-455.

34. Mugisha S., *et al.* "Computer-Mediated Therapies for Stroke: Meta-analysis of RCTs". *arXiv Preprint* (2024).

35. Saposnik G., *et al.* "Effectiveness of Virtual Reality Using Wii Gaming Technology in Stroke Rehabilitation". *Stroke* 42.5 (2011): 1380-1386.

36. Rodrigues P., *et al.* "Design and Evaluation of Virtual Reality-Based Telerehabilitation". *arXiv preprint* arXiv (2025): 2501.06899

37. Chen X., *et al.* "Stem Cell Therapy in Stroke: Meta-analysis of Randomized and Nonrandomized Trials". *Neurorehabilitation and Neural Repair* 38.1 (2024): 22-34.

38. Muir KW., *et al.* "PISCES-II: Neural Stem Cell Transplantation for Stroke Recovery". *Lancet Neurology* 22.5 (2023): 386-398.