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REVIEW

Outcomes in Patients with Minor Stroke: Diagnosis and Management in the Post-thrombectomy Era

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Abstract

In the era of mechanical thrombectomy and better preventative strategies, a higher number of patients are being discharged home from the hospital with the so-called minor strokes. This has significantly changed the landscape of stroke recovery. Unfortunately, while symptoms may be categorized as mild compared to individuals with higher NIH Stroke Scale scores, the physical, cognitive, and emotional sequelae can be disabling and result in failure to return to work and poor quality of life in a population with significant potential to recover fully. In this review, we discuss the current state of minor stroke, the most common pattern of resulting deficits, what is known about the underlying pathophysiology that leads to a relatively global pattern of impaired cognition following an infarct in any location, and special considerations for treatment based on this population's unique needs. Raising awareness of the current morbidity associated with minor stroke, the need for a uniform definition that allows for comparisons of individuals across studies, and further research focused on this population to optimize outcomes, has the potential to significantly improve recovery.

Keywords Minor stroke · Recovery · Cognitive decline · Depression · Outcomes

Introduction

Stroke has always been common and disabling [1]. However, over time, advancements in preventative strategies and acute treatments have altered the landscape of stroke recovery. Rothwell and colleagues first described a declining incidence of first-ever stroke between 1981 and 2004 in a large population of patients in England, associated with lower rates of smoking, baseline cholesterol and blood pressure, and higher rates of compliance with antiplatelet agents and statins [2]. Notably, 82% of these cases were considered non-severely disabling, or "minor." Additional studies have also reported lower stroke severity and better long-term recovery over time [3, 4]. Improvements in outcome have occurred, in part due to the increased use of intravenous tissue plasminogen activator (IV tPA) [5] and mechanical thrombectomy [6–9], effectively converting hemispheric strokes secondary to large vessel occlusions into smaller infarcts with higher potential for independence and "good recovery." While these advancements clearly represent a positive trajectory for stroke recovery, the new environment has resulted in an evolving set of challenges for patients, caregivers, and providers that must be addressed to optimize outcomes further.

Minor stroke is operationally defined as a small area of infarct resulting in relatively mild deficits and a generally good long-term outcome (Fig. 1). However, the formal definition that allows patients to be recruited into clinical trials and compared across studies is less clear. This can lead to varying reports of prognosis [10]. For practical reasons, in the majority of recent treatment trials, the NIH Stroke Scale (NIHSS) score has been used to delineate stroke severity and create the cohort of minor stroke patients [6–9]. Alternatively, some investigators have proposed limiting the definition to lacunar infarcts or lesions not involving a large vessel distribution to exclude larger infarcts in areas such as the right hemisphere where symptoms may be missed by traditional screening tests [11]. However, this requires work-up and imaging prior to delineation. Others have proposed definitions based on both radiographic and symptomatic variables [12]. Finally, the modified Rankin scale (mRS) and other measures of functional ability have been used to describe minimally disabling deficits, though more

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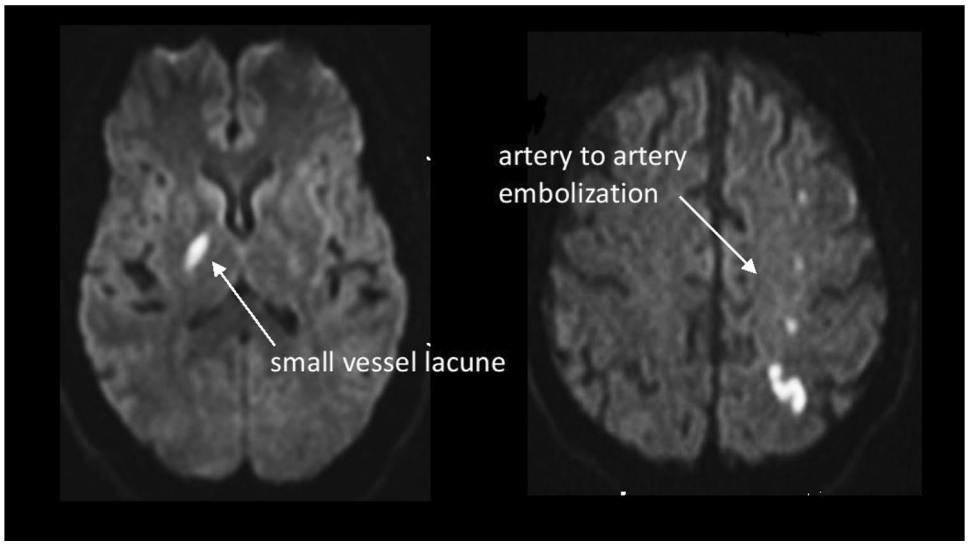


Fig. 1 Patients with minor stroke tend to have small, often subcortical infarcts either as the result of a lacunar infarct, small embolus, or recanalization of a large vessel occlusion. Note the sparing of larger cortical areas typically responsible for cognitive dysfunction

often these are reported as an outcome metric of a "good" or "non-disabling" functional outcome [13].

Patients with minor stroke are often younger (less than 65 years of age) and have tremendous potential to successfully return to their prior home and workplace environments. Unfortunately, there is an overwhelming feeling that having a minor stroke means that "the individual is fine, without any significant problems." In this way, minor stroke is somewhat of a misnomer. Since the early 2000s, symptoms such as mental fatiguability, difficulties in concentration and memory, impaired stress tolerance, and emotional lability have been described as "invisible disabilities" [14, 15] in individuals with stroke who lacked severe aphasia or hemiparesis. As described below, these deficits can make returning to a full-time job and interacting with friends and family challenging. This occurs in the same population who is often quickly discharged home from the hospital; and who themselves have high, and perhaps unrealistic, expectations for their immediate recovery [16]. Unfortunately, many of the reported deficits prove challenging to quantify and effectively rehabilitate using current paradigms traditionally tailored to more severe language and motor symptoms. This will ultimately require a shift in our assessment and treatment protocols to optimize impact.

Clinical Manifestations

Sensory-Motor/Physical Function

When considering minor stroke, distinct lacunar syndromes due to infarction of a single small vessel have been classically described [17]. Pathologically, the most common sites include the deep penetrating arteries feeding the basal ganglia, thalamus, pons, and internal capsule, resulting in sensory-motor symptoms with accompanying cranial nerve palsies or ataxia [17]. However, while a lacunar syndrome can result in an obvious and severe hemiparesis, patients can also present with pure sensory symptoms, less severe motor deficits, or involvement of only a single limb. This allows them to score fewer points on the NIHSS [18], but suffer disabling deficits with fine motor skills that impairs their ability to effectively use a knife and fork while out at a restaurant or open their own jar of pickles while at home. In these cases, it may be important to rethink the ways in which deficits are measured and quantified. Currently, low stroke severity scores make it difficult for a person to qualify for an intensive rehabilitation program. This is an important consideration because while absolute NIHSS was associated with long-term physical outcomes including dependence (mRS 3–5), 12% of those with an NIHSS of < 8 were dependent at 3 years despite relatively low scores [19]. Cognitive impairment and depression are also increasingly reported in conjunction with "pure" sensory or motor deficits, likely contributing to long-term morbidity. In response to these once under-appreciated clinical symptoms, scales including the Stroke Impact Score (SIS), have been developed that objectively obtain patient-reported outcomes. The SIS has been shown to be reliable, valid, and sensitive to change across patients with all stroke severities [20].

Along with motor strength, degree of physical activity significantly affects functional abilities after stroke, regardless of severity. Studies suggest that physical activity not only decreases the risk of recurrent stroke but may enhance neuroplasticity and lead to improved recovery beyond physical gains [21]. Evaluating the degree of physical activity after minor stroke illustrates the importance of pre-morbid function. Those out on sick leave prior to stroke report less physical activity one year after infarct. In fact, baseline status, along with poor balance at 3-months, and the presence

of anxiety, depression, or apathy was shown to have a tremendous impact on overall physical function [22]. This is particularly important for elderly individuals with premorbid unsteadiness, as new balance and gait problems can persist, even after a near-complete clinical recovery, putting patients at even higher risk for falls and decreased activity [23]. Braakhuis and colleagues evaluated a group of minor stroke survivors within the community and found that intensity of walking measured using an accelerometer was most important to evaluate physical capacity after minor stroke [24] and may be useful in clinical practice. Considering ways to preserve and improve physical function is critical to promote independence following minor stroke.

Language Abilities

In general, true aphasia, which occurs in up to one-third of all strokes [25], is less common in individuals with minor stroke, and recovers faster and more completely [26]. Subtle word finding difficulty, cognitive slowing, and apathy can also be misinterpreted by family and friends as a language or communication issue. The heterogeneity of these deficits often makes accurate quantification and classification of symptoms difficult; however, recognition of the spectrum of disease is important, as problems with communication significantly impair function and prolong recovery. The lack of true aphasia in the minor stroke population is likely because the NIHSS is biased toward the dominant hemisphere, resulting in points not only for "aphasia" but also providing the month or age, and the inability to follow commands [27]. In addition, motor pathways are closely juxtaposed to language areas within the vascular distribution of the middle cerebral artery, so accompanying hemiparesis, and a higher NIHSS score, is common [28]. A stroke mimic should be considered when aphasia presents in isolation [29]; however, smaller emboli can also result in pure language deficits. Studies have shown that providers are more likely to administer thrombolytics to an individual with a low NIHSS score when language deficits are present [30], speaking to the importance we place on communication as a society. This is a reasonable approach, as intravenous tPA has been shown to improve deficits irrespective of stroke size [31, 32], and language deficits predict a worse functional outcome long-term. Importantly, they can also mask other symptoms, including cognitive dysfunction.

Cognitive Impairment

Progressive vascular cognitive impairment due to the accumulation of white matter lesions, and post-stroke dementia due to large cortical infarcts have been well described [33–37]. However, The Secondary Prevention of Small Subcortical Strokes (SPS3) trial also found that up to 50% of patients hospitalized with lacunar infarcts who lacked cortical signs or physical disability also displayed rates of mild cognitive impairment in the months following their infarct [38]. Numerous additional studies have confirmed the common presence of cognitive decline [39–42].

Rather than the significant problems with language or memory that characterize patients with neurodegenerative disorders, after single small strokes patients typically display a phenotype of deficits more typical of a subcortical vascular dementia that affects multiple cognitive domains [43]. While Geurts and colleagues described poor delayed recall and recognition one week after minor stroke compared to controls [44], others have shown more significant difficulty with executive function, attention, and processing speed [45]. These deficits can be difficult to appreciate and are often described by the patient as feeling "foggy," "slow," or "just not quite right." They may be overlooked, especially in a busy clinic setting, particularly if the individual otherwise appears well and performs normally on a basic neurologic screening exam. They can, however, be captured on screening tests such as the Montreal Cognitive Assessment (MoCA)., which may be more sensitive than the MMSE for vascular related cognitive decline [46, 47]. Additional tests of executive function, processing speed, and verbal and spatial memory may then be required to sufficiently quantify deficits.

Cognitive decline has been reported immediately following [42], subacutely [43], and chronically [48] in patients with minor stroke. For the majority of individuals symptoms improve over time and a large number of patients are significantly better by 6-months post-infarct [48, 49]. However, up to one-third can be left with persistent deficits characterized by generalized cognitive dysfunction observed on a variety of neuropsychological tests and spanning multiple domains [50, 51]. Importantly, the subset of patients displaying acute cognitive deficits who initially recover also appear to have up to a fourfold increase in the rate of vascular dementia later in life compared to those who never exhibit cognitive symptoms [42]. Though it is unclear whether the same predisposing factors result in a higher risk of both persistent symptoms and subsequent late-life decline, the concept of "cognitive reserve" has been postulated to play a role. Marsh and others have found that higher levels of education and occupation class predicted a better peak recovery [43, 52], while McHutchison and colleagues estimated pre-morbid IQ and found an association between higher baseline intelligence scores and better cognitive performance at one- and three-years post-infarct [19]. There is also likely a component of brain health linking factors such as age, diabetes, and white matter disease to prognosis [53, 54]. Munir, et al. reported higher degrees of brain atrophy following infarct in patients with minor stroke compared to controls. It is possible this indicates a subclinical dementia or neurodegeneration

at baseline that confers greater risk for cognitive decline, though the direction of causality has yet to be established. What is clear is that factors indicating premorbid function (education and level of employment [41]) along with brain health (atrophy and white matter disease [55]) may be helpful indicators of cognitive reserve and predict longer-term trajectories. Whether, in addition there may be modifiable factors such as the brain's chemical milieu or functional connectivity on which we can intervene to optimize outcomes, remains to be seen and will be discussed below.

Neuropsychiatric Sequelae and Fatigue

Post-stroke depression has been reported in upwards of 25% of individuals. While most common in the initial stages of recovery, new diagnoses can occur months following hospitalization [56]. This may be in part due to the emotional toll a major life event can take on an individual. However, there is also the theory that an infarct may affect neurotransmitter systems, resulting in a higher rate of mood disorders [57]. A systematic review of studies between 1993 and 2013 showed post-stroke depression was no less common in individuals following minor stroke or transient ischemic attack (TIA) [58]. Qualitative interviews conducted by Kjaerhuage and colleagues revealed that many patients with minor stroke have trouble adjusting to their new role as a stroke survivor and have unmet needs for emotional support [59]. Increased levels of PTSD, fatigue, anxiety, and depression have been linked to significantly higher rates of disability and poorer quality of life [41, 56, 58].

In addition to depression, high levels of fatigue have been reported in the days to weeks following infarct [39]. Chen and colleagues found that the average score on the Functional Assessment of Chronic Illness Therapy (FACIT) [60] one-month post-stroke was similar to that of a cancer patient undergoing chemotherapy [61]. Rather than being associated with physical activity, the fatigue is often more associated with cognitive overload. Importantly, it is independent of depression, yet significantly impacts quality of life. Fortunately, it typically improves over time; yet, Morsund and colleagues found at least a low level of depression and fatigue still present at 12-months [50], so continued surveillance of symptoms is important. Notably, persistent fatigue after 6 months is often linked to an untreated or under-treated co-existing condition such as anemia, sleep apnea, or medication side effect, so additional factors should be considered and ruled out [61]. While it is unknown whether initially fatigue may be helpful to the recovery process, allowing the brain to rest and recover, there is some evidence that exercise and better sleep can improve patient perception of fatigue [62], suggesting potential treatment options. The use of stimulants or other pharmacological treatments requires further study.

The patient's support network is a critical factor for successful recovery, regardless of stroke severity. Green, et al. evaluated a group of male–female patient-caregiver dyads over time and reported that for many, marital function scores worsened from hospital discharge to one-month follow-up. This was associated with patient depression scores [63]. While there is limited data, a meta-analysis revealed that even a minor stroke commonly results in the re-evaluation of life plans, priorities, and the integration of disabilities into the current environment for both patients and their female caretakers [16]. Though these considerations apply to many stroke survivors, it can particularly complicate the normal aging process of elderly individuals and their families.

The neuropsychiatric sequelae of minor stroke can have significant implications on all aspects of recovery. Anxiety, depression, apathy, and fatigue have been associated with reduced physical activity 12 months after hospitalization [22]. While this does not necessarily imply causality, it suggests the need to identify and aggressively address mood disorders, a modifiable potential risk factor for poor prognosis. Tailoring interventions to patients with minor stroke may be different than for those with more severe deficits. Unfortunately, there is a lack of evidence regarding ongoing psychoeducational approaches to deal with the physical and emotional effects [64]. More rigorous study of this population is needed to better understand their needs and the effectiveness of interventions; however, Morsund and colleagues found a negative association between employment status and depression (those who were employed tended to report fewer depressive symptoms) [50], suggesting perhaps that facilitating re-entry into previous activities while aggressively treating the underlying mood disorder may be optimal.

Potential Pathophysiology: Network Dysfunction

When large cortical areas are infarcted, it is not surprising that individuals experience difficulties with specific cognitive functions. However, the majority of individuals with minor stroke present with small lesions that are subcortical in nature or outside of these traditional cortical areas. How then do they experience such significant impairment? The consistent phenotype of slowed processing speed, inattention, and poor executive function following a minor stroke of any location suggests a unifying pathophysiology. This process may be a generalized disruption of the cognitive networks [40]. Prior studies using fMRI have already confirmed that there is impaired functional connectivity after stroke in a variety of locations [65]. Patients with minor stroke simply lack other severe symptoms (hemiparesis, aphasia, hemispatial neglect) that confound the clinical picture and provides us the ability to evaluate the network-level component

leading to disruption without the confounding effect of a large area of cortical dysfunction. Granger causality can be used to formally evaluate functional connectivity using magnetoencephalography (MEG). MEG is an ideal tool when studying cognitive processes given its excellent temporal and spatial resolution. As patients with minor stroke demonstrate slowed reaction times that are on the order of milliseconds, it is able to observe even subtle differences between patients and controls during time-based tasks. Data collected from a small number of individuals shows that at one-month post-infarct patients demonstrate significantly fewer intra- and interhemispheric connections compared to age-similar controls (Fig. 2). Over the next six months, connections increase, corresponding to clinical improvement. Larger studies evaluating the contribution of specific cognitive networks, the patterns associated with better long-term prognosis, and whether the observed abnormalities are modifiable, are the logical next steps. Pendlebury and colleagues have demonstrated that very early cognitive decline following stroke predicts long-term risk for dementia; perhaps indicating a "cognitive fragility" [42]. Further work is needed to understand not only who is at highest risk for early cognitive impairment, but who is less likely to ultimately compensate and recover, and if restoration of network connectivity may be the key to improving function.

Promising Treatments

Rehabilitation

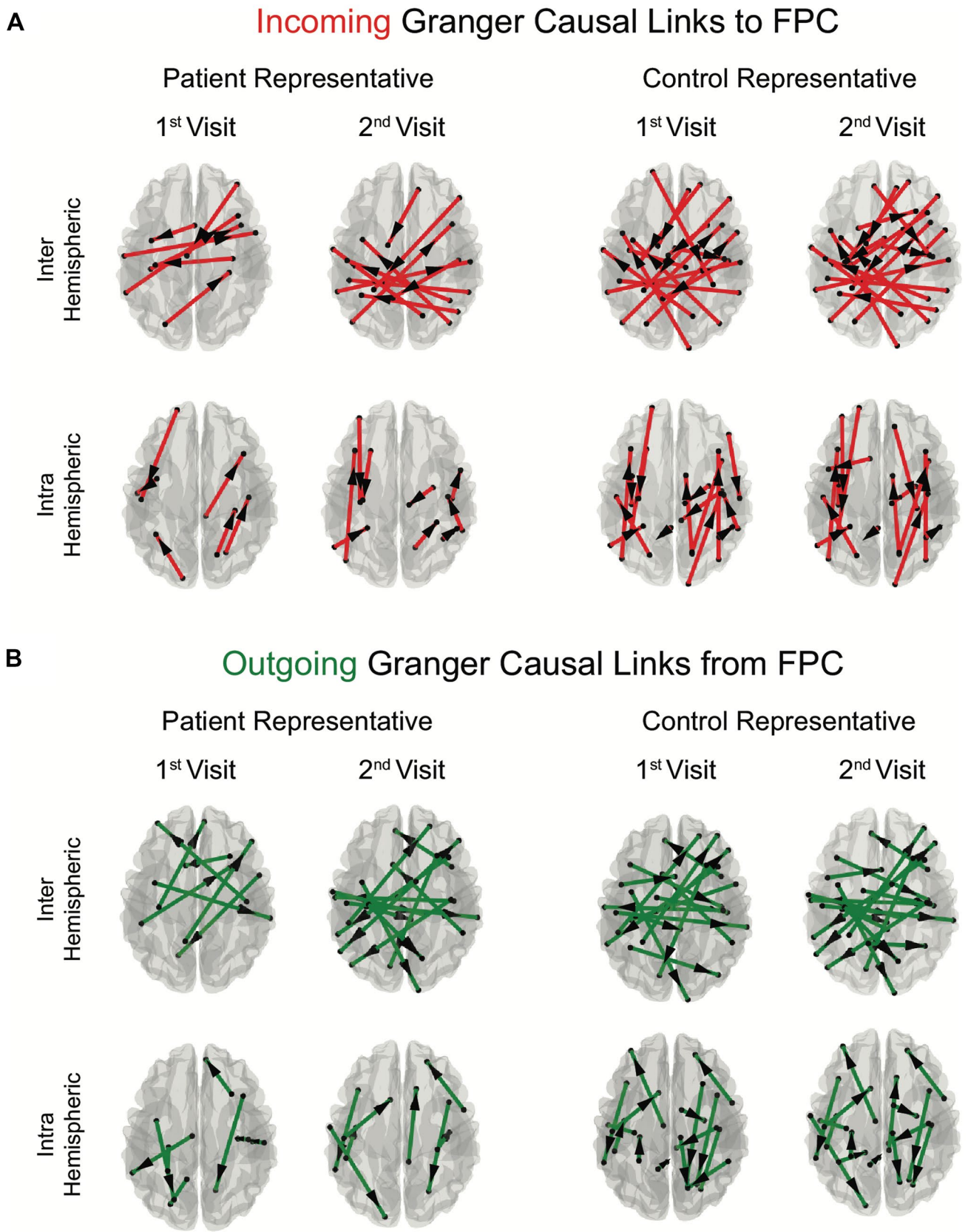
Rehabilitation is an important part of recovery for many stroke patients. However, its role for those with minor stroke is less well-defined. Certainly, patients presenting with hemiparesis or language deficits may benefit from post-discharge physical, occupational, or speech language therapy and be referred to acute inpatient rehabilitation programs; however, when deficits are mild or affect only one limb, patients are often discharged home with either outpatient rehabilitation recommendations or no rehabilitation plan at all. In 1998, Duncan and colleagues demonstrated that those with "mild deficits" could make significant rehab gains [66], though more work is needed to determine the effect of the intensity of rehabilitation on outcomes in this population. A recent meta-analysis found only 31 papers evaluating rehabilitation programs for patients with minor stroke and the majority focused on overall cardiovascular health and mobility [67]. Though memory problems are also commonly reported, data regarding outcomes following cognitive rehabilitation programs after stroke in general is also lacking. A 2016 meta-analysis found 13 studies that suggested at least some subjective benefit with memory over the short-term but insignificant long-term effects [68]. The quality of evidence was low, likely in part due to the heterogeneity of both the populations and rehabilitation programs studied. These studies are challenging given the need for programs specifically tailored to an individual's deficits; but will be important in allowing providers to ultimately advocate for the importance of resources for this population.

Though focal deficits may be lacking for many individuals, there are other considerations that make rehabilitation important. Patients with minor stroke can be deconditioned, either at baseline or after their hospital stay, even if brief. In addition, many have other needs related to co-existing medical conditions, especially cardiovascular disease. A generalized rehabilitation program may be helpful, especially for older adults with multiple comorbidities, to enhance overall physical activity and increase motivation to exercise [69]. Alternatively, especially for those who lack significant hemiparesis or physical deficits that may help them to qualify for rehabilitation, clinical prescriptive exercise programs have shown promise, especially in Europe, not only for improving function, but also for promoting good cardiovascular health and preventing recurrent vascular events [70–72]. For younger individuals, setting realistic expectations while in the hospital can help both the patient and their family to better anticipate issues when transitioning home, as well as the fact that any issues that they do face will most likely be transient. Early follow-up clinic visits should validate the presence of cognitive slowing and fatigue, but begin to focus on encouraging returning to work, even if in a limited capacity and with additional resources, to help to limit disability and promote independence.

Small Molecules

Functional imaging studies have shown decreased activation around the infarct, consistent with a spreading depression, that may prohibit plasticity [73]. Coupled with the possibility of disrupted neurotransmitter pathways leading to dysfunction [74], this has led to the hypothesis that using small molecules after stroke may lead to a faster and fuller recovery. Acetylcholinesterase inhibitors [75], NMDA inhibitors [76], catecholaminergics [77, 78], antidepressants [79], GABAergic agents, and other drugs [80] have all shown at least some promise in augmenting language recovery. However, results have been inconsistent [81, 82], perhaps due to the heterogeneity of the trials and populations evaluated, and many questions remain regarding the dosing, timing of treatment, and whether it may be an effective treatment in isolation or paired with other interventions [83–85].

Given the evidence of network dysfunction underlying the "minor stroke phenotype," it may be reasonable to consider augmentation with small molecules and observing the subsequent effects on functional connectivity as well as clinical cognitive results in our minor stroke patients.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◂**Fig. 2** Examples of detected links using Granger causality (GC) for one representative patient with minor stroke and one representative age-similar control. The arrows indicate the direction of the GC links coming into (**A**) and out of (**B**) frontoparietal cortex (FPC). For both connectivity types, the number of connections (most notably the inter-hemispheric links) increases for the patient over time, correlating with improved cognitive scores, whereas the connectivity patterns remain stable across the two visits for the control

Stimulants may appear to be an especially attractive option clinically, considering the significant degree of executive dysfunction, though one must take into account the potential side effects. They may also be reasonable to consider given the reported fatigue; however, we do not yet fully understand whether it is truly harmful or may be beneficial to the recovery process. Studies must be carefully designed and analyzed. The strongest case may be made for the use of antidepressants to aggressively treat both post-stroke depression, which is incredibly common after stroke, and resulting pseudodementia.

Neurostimulation

Transcranial direct current stimulation (tDCS) is a safe, non-invasive, non-painful electrical stimulation of the brain. The precise mechanisms of tDCS are unknown; however, it is thought that it changes the membrane potentials of neurons in a relatively focal area of brain tissue under the skull. By using anodal-tDCS to increase the likelihood of neural firing by inducing a subthreshold polarization that modulates the neuronal response threshold [86], one can increase cortical excitability and potentially promote long-term potentiation that facilitates task performance [87, 88]. A-tDCS has been widely used to treat post-stroke motor and language deficits by facilitating the lesioned hemisphere [89–91] and dramatically increasing the efficiency of rehabilitation protocols [92–95].

In a similar way, transcranial magnetic stimulation (TMS) has been studied as an adjuvant to behavioral interventions. Low frequency stimulation can be applied to the opposite hemisphere as an inhibitory signal in an attempt to increase activation within the lesioned hemisphere, or high frequency stimulation can be used ipsilesionally to induce firing and plasticity. A recent systematic review and meta-analysis found it to be more effective than sham when paired with conventional rehabilitation techniques [96, 97].

The ability of both forms of non-invasive neurostimulation has been evaluated, though to a lesser degree and with inconsistent results, to improve cognition. tDCS has been shown to improve working memory and attention in both individuals with schizoaffective disorders [98] and mild cognitive impairment [99]. Applying A-tDCS to the dorsolateral prefrontal cortex following stroke also showed promising results [100, 101]. Unfortunately, studies have been small ($n < 10$) with few sessions. Mixed with the heterogeneity of groups and lack of a clear therapeutic target in many cases has led to inconsistent results. We would argue, there is tremendous potential for further work. TMS has also been shown to improve perception, attention, memory, reasoning, and motor performance [102]. Given its excellent spatial resolution and ability to target specific brain areas, it may be the optimal choice for patients with large strokes affecting cortical areas. However, given the presence of network disruption, tDCS, with its wide dispersion, low cost, and portability, may be a more optimal choice for individuals with minor stroke. Because tDCS only produces a subthreshold response, it does not induce the firing of neurons unless they are near threshold. Therefore, pairing it with a task that specifically engages focal activation is most likely to engage the appropriate cognitive network and enhance plasticity [103, 104]. This has been best demonstrated in patients with aphasia [104–107], but most likely also applies to other cognitive domains. The timing of intervention will have to be considered. While patients in the chronic phase are easier to recruit and less likely to suffer from ceiling effects, the subacute phase of recovery may be the ideal time to intervene to enhance recovery as patients are already improving and reorganizing. Further trials are needed that specifically engage potential therapeutic targets, to determine the true efficacy of neurostimulation in this population.

Mindfulness-Based Stress Reduction

Given the difficulties with attention and concentration that are so prevalent in individuals with cognitive impairment after minor stroke, it is reasonable to consider paradigms that focus on retraining the frontal and temporal lobes. The practice of mindfulness dates back to ancient traditions focused on healing and the power of the mind [108]. It is thought to be an active process, engaging the frontal lobes, and it may be hypothesized that this "training" might improve or recover function. There is evidence that even short meditation sessions by those new to the practice can result in significant changes on EEG across all power bands [109]. The clinical correlation remains an area of open investigation.

Mindfulness-Based Stress Reduction (MBSR) is an 8-week program comprised of meditation, yoga, and body awareness. To date, it is the most evidence-based mindfulness intervention. It is gaining popularity as an effective treatment for anxiety and depression in both normal individuals and those with chronic disease states [110–113]; however, more recent studies suggest that incorporating MBSR can also result in improved performance on tests of executive function [114] and for individuals with Alzheimer's disease [115, 116]. Given the lack of significant side effects and increasing ability for one to participate virtually, or even using a smart phone application, its ability to reduce post-stroke-related mood disorders while improving cognition is promising.

Medical Management: Intervention, Discharge Support, and Prevention of Recurrent Events

Individuals hospitalized with minor stroke create a unique set of considerations for health care providers. The decision to administer intravenous tissue plasminogen activator when the NIHSS score is low can be challenging and is debated [117]. This is particularly problematic when considering large vessel occlusions involving the right hemisphere, which can present as minor symptoms given the low sensitivity of the NIHSS for the nondominant hemisphere [11]. While out of the scope of this review, the presence of disabling long-term deficits that can persist but are often under-recognized, especially in the acute setting. This raises the interesting question of whether treatment with interventions, including intravenous tissue plasminogen activator and mechanical thrombectomy, may result in greater impact that previously reported if different assessments and risk for early neurological deterioration are considered rather than shift in mRS [118–120]. Further studies are needed.

A second consideration in the overall management of minor stroke patients is the transition home, as the majority do not meet criteria for inpatient rehabilitation. Given mild symptoms, patients typically have short hospital stays, some after only observation in the Emergency Department, and are provided with variable follow-up, often with primary care provider rather than with a stroke specialist. This practice can be problematic on several levels. First, it results in the missed opportunity for education surrounding stroke risk factors and secondary prevention strategies. A significant portion of the hospital stay is comprised not only of diagnostic testing, but counseling and coordination of care. Equally important, however, is that time in the hospital allows the patient to process the significance of their recent infarct, to begin to see how it may impact their future, and to develop questions and concerns for the medical team. In one study, over 50% of those with minor stroke and transient ischemic attack reported issues with communication and cognition on returning home that were not adequately addressed [121]. In another small study of 20 patients, nearly half reported unmet needs two weeks post-discharge [122]. Rising healthcare costs and limited hospital resources require physicians to balance the need to reduce length of stay with the need to provide adequate education and support. The answer may lie in a more robust outpatient infrastructure for post-stroke follow-up with vascular neurology. When implemented in our health system, 30-day follow-up rates more than doubled while readmission rates dropped several percentage points and patient satisfaction scores increased [123].

For all stroke patients, the prevention of a recurrent event and management of medical comorbidities is critical during recovery. Secondary analysis of the SOCRATES trial [124], a secondary prevention trial comparing antiplatelet agents, found that 19% of patients with an NIHSS < 6 could be classified as disabled with a modified Rankin score of > 1 at 90 days. Age, diabetes, and admission NIHSS were strongly associated with outcomes, but recurrent stroke and medical complications appear to be the most significant contributors [125]. The risk of recurrence within the first week can be as high as 8–12% [126], so early work-up, effective secondary prevention strategies, and management to address comorbidities is critical. Data is accumulating for the use of dual antiplatelet therapy to prevent early recurrence and decrease disability [127].

Conclusions

Patients with minor stroke have significant potential to reintegrate into their prior home and workplace environments. Unfortunately, while this population can exhibit disabling deficits, medical providers often lack awareness of their needs [128] given that deficits can be difficult to appreciate. The resources to support transitions home and their unique rehabilitation needs are lacking. Increased recognition of "hidden deficits" along with a better understanding of both the symptomatology and pathophysiology will allow for development and optimization of treatment interventions. Further work is needed. Fortunately, the consequences of minor stroke and distinct challenges for this population have received increased attention in recent years. As we enhance our understanding of the pathophysiology, we will be better able to more fully rehabilitate those with minor stroke and improve outcomes.

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