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Poststroke chronic disease management: towards improved identification and interventions for poststroke spasticity-related complications

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This paper represents the opinion of a group of researchers and clinicians with an established interest in poststroke care and is based on the recognised need for long-term care following stroke, especially in view of the global increase of disability due to stroke. Among the more frequent long-term complications following stroke are spasticity-related disabilities. Although spasticity alone occurs in up to 60% of stroke survivors, disabling spasticity affects only 4–10%. Spasticity further interferes with important functions of daily life when it occurs in association with pain, motor impairment, and overall declines of cognitive and neurological function. It is proposed that the aftermath of stroke be considered a chronic disease requiring a multifactorial and multilevel approach. There are, however, knowledge gaps related to the prediction and recognition of poststroke disability. Interventions to prevent or minimise such disabilities require further development and evaluation. Poststroke spasticity research should focus on reducing disability and be considered as part of a continuum of chronic care requirements and should be recognised as a part of a comprehensive poststroke disease management programme.

Key words: assessment, burden, spasticity, stroke

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Introduction

The burden of stroke is increasing on a global scale and the associated long-term disability is also rising. Annually, 15 million people worldwide have a stroke. Five million die and another 5 million are left permanently disabled (1), with complications including motor (50–83%), cognitive (50%), and language impairments (23–36%) (2); poststroke seizures (10%) (3); neuropathic pain (8%) (3); and psychological disturbances (20%) (2). Estimates indicate that 33–42% of patients still require assistance for daily living activities three–six-years poststroke, and 36% of patients remain disabled after five-years (4). Stroke and its subsequent disabilities place a large burden on the family and community (1), accounting for approximately 2–4% of total health care costs globally (5) with a lifetime cost estimated at US$1 40 048 in the United States and 43 129 in Europe (3).

The global prevalence of stroke is increasing (2). Based on data from the World Health Organization (1), survival time after a first stroke may be as low as two–three-years in regions such as Africa or Southeast Asia, whereas in the United States, the median survival time ranges from approximately six- to

eight-years for patients older than 60-years (6). One-third of stroke patients are under the age of 65 (7), which has important implications as younger patients may live with disabilities for even longer periods. Despite these facts, the long-term impact of stroke and the availability of health care services remain largely unassessed within the global context (8). Although studies have evaluated short-term poststroke outcomes, such as motor impairments, cognitive dysfunctions, and language difficulties (2), longer term stroke follow-up studies focus primarily on mortality (9). The long-term impact on stroke caregivers is poorly understood, although short-term data suggest that caregivers suffer from higher rates of emotional and physical symptoms compared with noncaregivers (10, 11). With approximately one-third of the treatment cost of stroke attributable to rehabilitative care, the economic implications of chronic poststroke disability may be considerable (9, 12). Thus, stroke chronic disease management should be recognised as a public health priority by governments and health authorities.

Some evidence-based guidelines are available; however, their application varies. There is a need to establish how more consistent application of current guidelines can improve stroke recovery and outcomes. For example, models exist for improving stroke systems of care (13–15); however, successful implementation of these guidelines may be hampered by a number of factors, including lack of adherence to guidelines and policies (16), limited access to resources and stroke care facilities (17–20), and variability in provider education and skills (17, 19, 21). It may also be difficult to assess the efficacy of patient adherence to recovery strategies once patients have left the hospital.

High-quality stroke care represents a continuum comprising primordial/primary prevention, acute/emergency care, recovery and rehabilitation, and secondary prevention (12). There are several gaps in the continuum within 'organised' systems of stroke care that may contribute to suboptimal patient outcomes. First, few patients admitted to hospitals for acute stroke receive care in a specialised stroke unit. A recent study showed that only 8·5% of stroke patients in Europe received care at comprehensive or primary stroke centres (22). In low-income countries, this number is likely even lower. A review of stroke care in developing countries reported that the number of stroke units per 100 million people ranged from approximately three to 30 (17). Although vascular neurologists are an important part of poststroke management, they are involved to varying degrees throughout the continuum, and may have limited interaction with patients after acute hospitalisation. In the United States, $<40\%$ of stroke victims receive care from a board-certified neurologist and much fewer from a board-certified vascular neurologist (23).

Another significant challenge to the continuum of stroke care occurs during long-term recovery. Patients are often advised after 6–12-months that they have reached a plateau in their recovery, and it is not uncommon for insurance providers to stop reimbursement once patients fail to demonstrate functional improvements in response to continued treatment (24). In addition, these practices may condition patients not to expect further recovery once this 'plateau' is reached, causing them to give up and thereby preventing them from achieving even greater functional gains (24). Both patients and physicians should be aware that stroke is a chronic disease that should be managed on a continual basis in order to sustain functional gains and address new problems that may arise.

Stroke survivor, caregiver, and health care professional motivation and empowerment are essential to achieving improvements in the continuum of care. Despite the perception that patients reach a limit in their recovery within 6–12-months, results from several studies suggest that these plateaus may not be caused by patients' reduced capacity for motor recovery, but by adaptive states that occur as patients become physiologically accustomed to rehabilitation exercises (24). Some studies, although with small numbers of patients, have indicated that chronic stroke patients can exhibit continued motor improvement with novel rehabilitation protocols (24). Patients and stroke care providers should be proactive about continually seeking new ways to enhance recovery.

One well-known consequence of stroke is poststroke spasticity (PSS), which is defined as a velocity-dependent hyperexcitability of muscles to stretch and is characterised by exaggerated deep tendon reflexes, increased resistance to passive movement, and hypertonia resulting from loss of upper motor neuron inhibitory control (25). It is well recognised that PSS impacts chronic poststroke disability (26). The PSS may interfere with motor and activity performance, cause pain, and lead to secondary complications, such as contracture or weakness, which may further contribute to poststroke disability (26). The prevalence and impact of PSS and related complications are not well understood, and epidemiological data regarding PSS are limited.

PSS-related complications

It is likely that PSS-related complications are not due to spasticity alone and that other factors contribute to its impact (26). Pain and deformity associated with spasticity can increase disability (e.g., reduced mobility, self care, and ease of hygiene), increase complications (e.g., pressure sores), and create a vicious cycle of poor posture that may exacerbate the spasticity (27). Uncontrolled spasticity can lead to permanent contracture in the muscles and soft tissues (27). Weakness results from a loss in muscle strength due to upper motor neuron syndrome, whereas contracture can arise as a result of joint, muscle, or soft tissue limitations (28). Careful evaluation is therefore required to establish the cause of the patient's disabilities before deciding on the best rehabilitation approach.

Clinicians often focus on the direct effects (i.e., impairment) of PSS, such as increased muscle tone, rather than indirect effects (i.e., limitation of activities) that more importantly impact daily functioning and quality of life. For example, direct effects include the inability to open the hand, whereas indirect effects include an impaired ability to grip objects or clean the hand. This presents challenges to the identification

and treatment of PSS. The PSS-related complications may interfere with a variety of functional activities, such as cleaning hands, dressing, or eating; personal responsibilities, such as housework or childcare; and workplace activities (29). Even among those deemed 'recovered' from stroke based on a Barthel index score of ≥ 95, they still can have difficulties with hand function, dependence in daily activities, impaired overall physical function, and limitations of social participation, all of which may impair quality of life (30). Clinical measures alone underestimate the impact of PSS on patients' functioning and quality of life, and clinicians should therefore seek to understand the patient's condition in terms of PSS-related complications or disabling PSS. Additionally, efforts should focus on educating patients, caregivers, and clinicians on indirect effects and secondary complications associated with PSS and their impact on rehabilitation and recovery.

Areas that need further research

There is currently an unmet need for an increased understanding of PSS and related disabilities. In particular, there is a need to better understand specific PSS-related complications within the context of the following domains:

The proportion of patients who experience PSS-related complications

The prevalence of PSS ranges from as low as 1% (26) to as high as 60% (31) depending on the poststroke population assessed. One cohort study (32) reported that 39% of patients with first-ever stroke are spastic after 12-months, while another study (33) reported a prevalence of 17% for spasticity and 4% for disabling spasticity one-year after stroke. The overall prevalence of PSS-related complications, however, has not been well studied. There is a clear need for further data to define and identify the prevalence of PSS and its complications.

The onset time of PSS-related complications

It is recognised that a lag may exist between stroke and the onset of PSS; however, few studies have investigated the time to onset of either PSS or its related complications. One study (26) of 95 patients with first-ever stroke (26) found that 21% were initially (mean, 5·4-days) spastic according to the modified Ashworth Scale, while 19% were spastic three-months after stroke. Some of the patients who were spastic at three-months developed spasticity after the initial evaluation (26). Further research is needed to aid clinicians in anticipating the onset of spasticity and other common complications following stroke.

How quickly PSS-related complications stabilise

A cohort study (34) evaluating the recovery of motor function after stroke found the most dramatic improvement occurred during the first 30-days regardless of the initial severity of the stroke, although patients with moderate and severe strokes continued to recover for 30–90-days after the stroke. Spasticity is generally thought to reach its maximum one–three-months after stroke (26); however, functional scales may be insensitive to further improvements (35) and additional research is needed to better define PSS stabilisation.

Whether PSS is helpful in some patients

Anecdotal examples suggest that PSS may benefit some patients with underlying muscle weakness; however, as yet the circumstances in which spasticity may be a positive phenomenon is not clear (36). Some patients, such as those with poor lower limb tone (36) or upper motor neuron weakness (27), may benefit from the increased tone associated with spasticity, helping them to improve their posture and maintain or improve their ability to stand and walk. Further research is needed to clarify the potential benefits associated with PSS, in contrast to the large evidence base supporting the need to identify and treat disabling PSS when it occurs.

Identification and diagnosis

Early intervention may reduce the development of spasticity after stroke (37) and early identification of high-risk patients is essential. Therefore, factors that predict which patients are at high risk for development of PSS should be identified. Recent research has proposed a Cox linear regression model (36) that predicts the presence of clinically detectable spasticity at 12-months poststroke (36). The model incorporates data routinely collected following admission for acute stroke, including prestroke Rankin Scale score, age, gender, urinary continence at day 7, presence of hemiplegia at admission, and smoking status. The model had both a sensitivity and specificity of 77%, a positive predictive value of 65%, and a negative predictive value of 86%. Another model (37) found that a low day 7 Barthel index score combined with early arm or leg weakness was associated with some spasticity at 12-months after stroke, whereas low day 7 Barthel index score combined with left-sided weakness and smoking status were associated with more severe spasticity at 12-months. Further prospective testing is required to establish the validity, reliability, and utility of these and other models, and to determine if incorporating additional data could improve their predictive value.

Individual measures of PSS and its related complications may also help to facilitate earlier identification and intervention. Unfortunately, there is no simple measure of PSS. Neurophysiological measures, such as H-reflex, F-wave, or muscle response to externally imposed perturbation, can only measure specific aspects of spasticity (38). Biomechanical measures provide an indirect assessment by quantifying stiffness, posture at rest, and range of movement. Spasticity is detected clinically by an increased response to passive movement (36), and in the research setting by clinical measures such as the Tardieu method, the Ashworth Scale, the Rankin Scale,

and the Barthel index, among others; however, these measures also have limitations (38). The Ashworth Scale (38) is commonly used to measure the severity of spastic hypertonia, but it has limited clinical relevance because it does not measure PSS-related complications. The Tone Assessment Scale (36) allows assignment of a global spasticity score that incorporates response to passive movement, resting posture, and associated reactions, but it has not yet demonstrated reliability. The Stroke Impact Scale (4) measures impairment, disability, handicap, and quality of life as a result of stroke, but it has not been tested in a population-based setting for long-term outcomes.

Ideally, measures of PSS-related complications should be based on individualised patient goals, and may include function, symptoms, postural assessments, and quality of life measures. Measures including assessment of daily living activities and quality of life may also help to motivate payers and ensure patient access to treatment. Although some studies find weak or moderate associations between spasticity and activity performance or health-related quality of life (26, 39), tools for identifying disabling spasticity with a need for interventions remain scarce (33).

Treatment of PSS

The decision to treat should depend on the individual patient's needs. Poststroke spasticity may have nondisabling effects in some patients and even be helpful effects in others; for example, patients with underlying muscle weakness may benefit from improved posture and the ability to sit upright (36). The PSS should be treated when it interferes with daily living activities and/or function, such as maintaining personal hygiene, dressing, writing, and social/interpersonal issues.

Opportunities for improving the management of PSS-related disability include treatment of spasticity itself as well as complications associated with PSS. There are a large variety of treatment options, including physical and occupational therapy, electromagnetic stimulation, casting, and pharmacotherapy (systemic and focal) (28, 36). Additionally, better clinical outcomes have been noted when postacute stroke patients receive coordinated, multidisciplinary intervention involving a physician, nurse, physical therapist, occupational therapist, kinesiotherapist, speech and language pathologist, psychologist, recreational therapist, and family/caregivers (14). Because of the complexity of treatment, additional data are needed to establish how treating PSS improves related functional and quality of life issues.

Treatment should address exacerbating factors such as infection, pain, constipation and other nociceptive influences, and careful positioning throughout 24 h to maintain muscle length and reduce deformity (27, 28). Physiotherapy programmes aim to improve motor performance partly through manipulation of muscle tone and typically includes stretching and/or contraction of muscles in the limbs and maintenance of joint movement (27, 28). For some patients, physiotherapy may also include casting or splinting to maintain muscle stretch and the use of heat or cold to reduce spasticity (28). Electrical stimulation produces short-lived reductions in spasticity and improves walking for some patients. Evidence for antispastic effects of electric stimulation is limited and studies indicate it may be most beneficial when combined with focal pharmacologic therapies, such as botulinum toxin (28). In cases of established contracture, surgical release may correct deformity and facilitate better postures (e.g., standing) to prevent further spasticity (27, 28).

Systemic antispasmodic drugs (e.g., baclofen, diazepam, dantrolene, and tizanidine) may also be used to reduce spasticity (27, 40). These drugs produce generalised muscle weakness, potentially reducing muscle tone (27, 28). Other agents with potential benefit include clonidine, cannabis, oral delta-9-tetra-hydrocannabinol, and gabapentin, although additional research evaluating these agents for PSS is needed (40). Because of the limitations of other pharmacologic agents, treatment policies have changed towards increasing use of intramuscular botulinum toxin, which currently is considered the treatment option of choice for upper limb focal spasticity based on the strong evidence base (33, 41). In a prospective trial, comprehensive focal spasticity management including botulinum toxin and physiotherapy improved patients' perceived health-related quality of life and motor functions (42). The PSS-related disability, such as poor hand function, involves both spasticity and weakness and needs to be addressed using a combination approach (35). For example, although spasticity is often thought to be the cause of reduced wrist and finger extension with some preservation of flexion, poor motor control with weakness is typically the actual primary cause of disability (26). Treatment with botulinum toxin in arm muscles reduces excessive flexion and associated pain, spasms, or postures that interfere with patients' self-care (35, 43); however, in contrast to other spasticity agents (27), botulinum toxin does not induce muscle weakness (35, 43). One other study (44), botulinum toxin did not enhance improvement of upper limb function within 12-months in poststroke upper extremity therapy or change spasticity in a significantly measurable way. Optimal therapy for PSS and related complications should generally involve a combination of therapeutic approaches to address the diverse aspects of physical disability and impairment.

In summary, poststroke chronic disease management is a multifactorial and multilevel process with large regional variations and unmet needs around the globe. Strongly influenced by stroke severity, location of the stroke within the brain, concomitant neurological deficits, and resulting disability, it is further affected by individual and social traits as well as socioeconomic determinants. Among these many factors, spasticity-related complications deserve special attention.

Poststroke spasticity has a significant impact on long-term disability, although gaps in knowledge and recognition of the symptoms remain. A better understanding of the prevalence and time to onset of PSS-related complications and the establishment of clinically useful measures of PSS that incorporate its

impact on daily functioning and quality of life are needed. Management of patients with PSS should focus on the disability produced by PSS, not simply the spasticity itself, and will therefore generally integrate multiple therapeutic approaches.

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