Brazilian practice guidelines for stroke rehabilitation: part II

Diretrizes brasileiras para reabilitação no acidente vascular cerebral: parte II

Cesar Minelli[1,2,3] Gustavo José Luvizutto[4] Roberta de Oliveira Cacho[5] Luciana de Oliveira Neves[6] Sheila Cristina Sayuri Abe Magalhães[7] Marco Túlio Araújo Pedatella[8,9,10,11,12] Lucia Iracema Zanotto de Mendonça[13,14] Karin Zazo Ortiz[15] Marcos Christiano Lange[16] Priscila Watson Ribeiro[7] Luciane Aparecida Pascucci Sande de Souza[4] Cristiano Milani[17] Daniel Marinho Cezar da Cruz[18] Rafael Dalle Molle da Costa[7] Adriana Bastos Conforto[19,20] Fernanda Martins Maia Carvalho[21] Bruna Silva Ciarlini[21] Norberto Anizio Ferreira Frota[21] Kelson James Almeida[22] Eliane Schochat[23] Tatiana de Paula Oliveira[23] Camila Miranda[23] Maria Elisa Pimentel Piemonte[23] Laura Cardia Gomes Lopes[24] Camila Galvão Lopes[25] Michelle Hyczy de Siqueira Tosin[26,27] Bianca Campos Oliveira[26] Beatriz Guitton Renaud Baptista de Oliveira[26] Shamyr Sulyvan de Castro[28] João Brainier Clares de Andrade[29] Gisele Sampaio Silva[20,29] Octávio Marques Pontes-Neto[2] João José Freitas de Carvalho[30] Sheila C. Ouriques Martins[31,32,33] Rodrigo Bazan[7]

1 Hospital Carlos Fernando Malzoni, Matão SP, Brazil.
2 Universidade de São Paulo, Faculdade de Medicina de Ribeirão Preto, Departamento de Neurociências e Ciências do Comportamento, Ribeirão Preto SP, Brazil.
3 Instituto Você sem AVC, Matão SP, Brazil.
4 Universidade Federal do Triângulo Mineiro, Departamento de Fisioterapia Aplicada, Uberaba MG, Brazil.
5 FUniversidade Federal do Rio Grande do Norte, Faculdade de Ciências da Saúde do Trairi, Santa Cruz RN, Brazil.
6 Universidade de Fortaleza, Hospital São Carlos, Fortaleza CE, Brazil.
7 Universidade Estadual Paulista, Faculdade de Medicina de Botucatu, Botucatu SP, Brazil.
8 Hospital Israelita Albert Einstein, Unidade Goiânia, Goiânia GO, Brazil.
9 Hospital Santa Helena, Goiânia GO, Brazil.
10 Hospital Encore, Goiânia GO, Brazil.
11 Hospital Estadual Geral de Goiânia Dr. Alberto Rassi, Goiânia GO, Brazil.
12 Hospital de Urgência de Goiânia, Goiânia, GO, Brazil.
13 Universidade de São Paulo, Faculdade de Medicina, Hospital das Clínicas, Divisão de Neurologia, São Paulo SP, Brazil.
14 Pontíficia Universidade Católica de São Paulo, Faculdade de Ciências Humanas e da Saúde, São Paulo SP, Brazil.
15 Universidade Federal de São Paulo, Escola Paulista de Medicina, Departamento de Fala, Linguagem e Ciências Auditivas, São Paulo SP, Brazil.
16 Universidade Federal do Paraná, Complexo Hospital de Clínicas, Curitiba PR, Brazil.
17 Universidade de São Paulo, Faculdade de Medicina de Ribeirão Preto, Hospital das Clínicas, Serviço de Neurologia Vascular e Emergências Neurológicas, Ribeirão Preto SP, Brazil.
18 Leeds Beckett University, Leeds, United Kingdom.

Address for correspondence Cesar Minelli (e-mail: cdminelli@yahoo.com.br).

19 Universidade de São Paulo, Hospital das Clínicas, Divisão de Neurologia Clínica, São Paulo SP, Brazil.
20 Hospital Israelita Albert Einstein, São Paulo SP, Brazil.
21 Universidade de Fortaleza, Programa de Pos-Graduação em Ciências Médicas, Fortaleza CE, Brazil.
22 Universidade Federal do Piauí, Departamento de Neurologia, Teresina PI, Brazil.
23 Universidade de São Paulo, Faculdade de Medicina, Departamento de Fisioterapia, Fonoaudiologia e Terapia Ocupacional, São Paulo SP, Brazil.
24 Universidade Estadual de São Paulo, Faculdade de Medicina de Botucatu, Hospital das Clínicas, Departamento de Neurologia, Psicologia e Psiquiatria, São Paulo SP, Brazil.
25 Hospital Santa Paula, São Paulo SP, Brazil.
26 Universidade Federal Fluminense, Niterói RJ, Brazil.
27 Rush University, Chicago, United States.
28 Universidade Federal do Ceará, Departamento de Fisioterapia, Fortaleza CE, Brazil.
29 Universidade Federal de São Paulo, São Paulo SP, Brazil.
30 Hospital Geral de Fortaleza, Faculdade de Medicina Unichristus, Fortaleza CE, Brazil.
31 Rede Brasil AVC, Porto Alegre RS, Brazil.
32 Hospital Moinhos de Vento, Departamento de Neurologia, Porto Alegre RS, Brazil.
33 Hospital de Clínicas de Porto Alegre, Departamento de Neurologia, Porto Alegre RS, Brazil.

Arq. Neuropsiquiatr. 2022;80(7):741–758.

received
February 4, 2022
accepted
May 18, 2022

DOI https://doi.org/10.1055/s-0042-1757692.
ISSN 0004-282X.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Abstract

The Brazilian Practice Guidelines for Stroke Rehabilitation – Part II, developed by the Scientific Department of Neurological Rehabilitation of the Brazilian Academy of Neurology (Academia Brasileira de Neurologia, in Portuguese), focuses on specific rehabilitation techniques to aid recovery from impairment and disability after stroke. As in Part I, Part II is also based on recently available evidence from randomized controlled trials, systematic reviews, meta-analyses, and other guidelines. Part II covers disorders of communication, dysphagia, postural control and balance, ataxias, spasticity, upper limb rehabilitation, gait, cognition, unilateral spatial neglect, sensory impairments, home rehabilitation, medication adherence, palliative care, cerebrovascular events related to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, the future of stroke rehabilitation, and stroke websites to support patients and caregivers. Our goal is to provide health professionals with more recent knowledge and recommendations for better rehabilitation care after stroke.

Keywords

- Stroke
- Neurological Rehabilitation
- Health Planning Guidelines
- Practice Guidelines as a Topic

Resumo

As Diretrizes Brasileiras de Reabilitação do Acidente Vascular Cerebral (AVC) - Parte II, desenvolvida pelo Departamento Científico de Reabilitação Neurológica da Academia Brasileira de Neurologia é voltada para intervenções específicas de técnicas de reabilitação de déficits neurológicos e incapacidades. Seguindo o mesmo modelo da Parte I, a Parte II também se baseia em estudos randomizados, revisões sistemáticas, metanálises e outras diretrizes sobre o mesmo tema. A segunda parte aborda os distúrbios da comunicação, disfagia, controle postural e equilíbrio, ataxias, espasticidade, reabilitação do membro superior, marcha, cognição, negligência espacial unilateral, déficits sensoriais, reabilitação domiciliar, aderência ao uso de medicamentos, cuidados paliativos, o futuro da reabilitação no AVC, e *websites* de orientação sobre AVC para pacientes e cuidadores. Nosso objetivo é fornecer aos profissionais envolvidos na reabilitação conhecimento atualizado e recomendações para um melhor cuidado no pós-AVC.

Palavras-chave

- Acidente Vascular Cerebral
- Reabilitação Neurológica
- Diretrizes Para o Planejamento em Saúde
- Guias de Prática Clínica Como Assunto

INTRODUCTION

Stroke causes significant brain tissue damage and multiple neurological impairments, leading to a significant loss of function and residual disability.[1]

The main goal of stroke rehabilitation is to organize and optimize the process of recovery, enabling a person to achieve their optimal physical, cognitive, communicative, emotional, and social levels of functioning through the integration of interdisciplinary rehabilitative techniques.[2]

In stroke recovery, it is necessary to consider the greater improvement that occurs in the first three months.[3] During this phase, variable spontaneous neurological improvement can be considered a confounder in the assessment of the rehabilitation intervention.[3] However, progress in functional outcomes after three months seems to be largely dependent on learning adaptation strategies.[4] Improvement probably occurs through a complex combination of spontaneous recovery and learning-dependent processes, including restitution, substitution, and compensation.[4] Neurological repair probably occurs through brain reorganization, leading to true recovery associated with compensation and restitution in the later phases after stroke.[5] Active, functional, and independent movement contribute to the brain reorganization after stroke and could be a key component in motor learning and rehabilitation.[6,7]

The purpose of the Brazilian Practice Guidelines for Stroke Rehabilitation - Part II is to guide health professionals working in stroke rehabilitation with evidence from the most recent studies available. Brazilian versions of outcome measures used in stroke rehabilitation are presented in the ►**Supplementary Material**. The literature on interventions for each impairment and disability situation is presented, followed by practical recommendations. The classification of recommendation rating and level of evidence used in Part I was followed.[8]

The main challenge in developing this guideline was the heterogeneity and paucity of high-quality evidence to support intervention recommendations. Some meta-analyses of each intervention were based on low- or very low-quality evidence due to unclear or high risk of bias and the recruitment of small samples.[7] Following the same methods used to write Part I, the members of the Scientific Department of Neurological Rehabilitation of the Brazilian Academy of Neurology participated in online discussion forums with predefined topics, followed by videoconference meetings in which controversies were discussed, leading to a consensus. For the preparation of the Brazilian Practice Guidelines for Stroke Rehabilitation, several national coauthors were asked to write the suggested topics following criteria defined by the guideline coordinators. The present work focuses on recent clinical trials, meta-analyses, and systematic reviews in the literature on stroke rehabilitation.

RECOMMENDATION RATING AND LEVEL OF EVIDENCE

Recommendations

- Class I: There is evidence and/or consensus that the intervention is effective;

- Class II: There is conflicting evidence and/or divergence of opinions about the effectiveness and usefulness of the intervention:

– IIa: Although there is divergent evidence on the usefulness and effectiveness of the intervention, the recommendations are in favor of the intervention;
– IIb: Utility and effectiveness are less established by the evidence or opinions;

- Class III: There is evidence and/or consensus that the intervention is not useful or effective and may cause harm.

Level of evidence*

- A: Data are obtainded from multiple randomized clinical trials.
- B: Data are obtained from a single randomized or non-randomized study.
- C: Consensus and expert opnions, case studies, or standart treatments.

* Recommendations of systematic reviews and meta-analyses based on very low- to low-quality evidence were classified as level "B" of evidence.

DISORDERS OF COMMUNICATION: APHASIA, DYSARTHRIA, AND APRAXIA OF SPEECH

The incidence of aphasia and dysarthria after a first stroke is of approximately 30% and 42% respectively.[9] Regarding the survivors six months poststroke, 35% remain aphasic and 57%, dysarthric.[9] The presence of apraxia of speech (AOS) alone is rare, co-occurring with aphasia in $\sim$30% of the cases. Aphasia is associated with a longer hospital stay and greater mortality and morbidity. Disorders of aphasia, AOS, and dysarthria negatively impact the ability to work, lead to social withdrawal, and increase the risk of developing anxiety and depression.

Speech and language therapy is indicated for all patients with aphasia. A systematic review demonstrated that access to speech and language therapy benefits the functional use of language, language comprehension (listening or reading), and language production (speaking or writing) when compared with no access to therapy.[10] Furthermore, functional communication was significantly better in people with aphasia submitted to therapy at a high intensity, high dose, or over a long period compared with those submitted to therapy at a lower intensity, lower dose, or over a shorter period.[10] There is a consensus that intervention should start early.[10] However, a recent prospective, randomized, single-blinded trial[11] aimed to determine whether intensive aphasia therapy, beginning within 14 days after stroke, improved communication recovery. The authors[11] found that early, intensive aphasia therapy did not improve communication recovery within 12 weeks poststroke compared with usual care. However, they[11] pointed out that most participants, regardless of group allocation, achieved significant clinical gains in language recovery.

Regarding AOS, the articulatory–kinematic approach is the most used, studied, and recommended to improve speech sound accuracy.[12] Speech therapy also positively affects the recovery of patients with dysarthria.[13] A meta-analysis[14] of patients with poststroke dysarthria showed that the alternating and sequential motion rate and maximum phonation time improved significantly after speech rehabilitation.

The evidence that repetitive transcranial magnetic stimulation (rTMS) with transcranial direct current stimulation (tDCS) is effective in the treatment of aphasia is of low to moderate quality.[15–19] Low frequency rTMS applied over the right inferior frontal gyrus is probably effective in promoting the recovery of non-fluent aphasics in the chronic stage of stroke, especially if used in combination with speech and language therapy.[20] Anodal tDCS applied over the left inferior frontal gyrus is supported by evidence of moderate quality for its efficacy in the naming of nouns, but not verbs, in non-fluent aphasics in the chronic phases of stroke, with possible maintenance of gains during follow-up.[20] Few studies on apraxia of speech and dysarthria have been conducted, and those available only involve small samples.

The positive results reported in meta-analyses and systematic reviews do not necessarily reflect meaningful clinical benefits.[15] Differences in the methodologies employed to analyze study data lead to different levels of evidence.[15] Patient responses to stimuli vary greatly due to individual factors and different mechanisms of functional reorganization of the brain following stroke, which are poorly understood.[19] The strategy of applying inhibitory or excitatory stimuli to the left or right hemispheres may not be the optimal approach, and the best site and paradigm for stimulation must first be determined.[16] The evidence supporting the benefits of rTMS and tDCS is preliminary, and there is no consensus on the therapeutic use of these techniques in the clinical practice.[16–19]

Regarding the pharmacological approach, donepezil and memantine have been shown to improve several aspects of language;[21] the effects of galantamine, amphetamines, and levodopa remain inconclusive; bromocriptine demonstrated no benefits,[21] whereas piracetam promoted a transient limited effect.[22]

Recommendations

- Speech and language therapy should be started early for all poststroke patients with aphasia (Recommendation I-A);

- The effectiveness of combined early and intensive aphasia therapy is uncertain (Recommendation IIb-A);
- For AOS, an articulatory–kinematic approach is recommended (Recommendation IIa-A);
- Speech therapy is indicated for dysarthria rehabilitation (Recommendation IIa-A);
- The benefits of rTMS and tDCS in poststroke aphasia rehabilitation are uncertain (Recommendation IIb-A), as well as in AOS and dysarthria rehabilitation (Recommendation IIb-C);
- Donepezil and memantine can be used for poststroke aphasia treatment (Recommendation IIa-A);
- There are no recommendations for the use of piracetam, bromocriptine, galantamine, levodopa, or amphetamines (Recommendation III-A).

DYSPHAGIA

Dysphagia occurs in 65% to 90% of stroke patients and is associated with aspiration pneumonia, dehydration, malnutrition, and increased mortality.[23] Although spontaneous recovery from dysphagia occurs in stroke patients, 11% to 50% will have permanent dysphagia up to 6 months after the stroke, increasing the risk of pneumonia 3-fold. In poststroke patients with laryngotracheal aspiration, pneumonia is eight times higher.[23]

Dysphagia screening should be performed early, and bedside evaluation can provide valuable information.[24] However, bedside evaluation alone cannot detect aspiration without clinical signs.[25] If silent aspirations are suspected, videofluoroscopy and fiberoptic endoscopic evaluations are appropriate methods to evaluate the swallowing mechanism.[26,27]

Rehabilitation of dysphagia in stroke patients is based on the concept of neuroplasticity; it involves compensatory strategies and modification of the physiology of swallowing. Compensatory strategies include volume and texture modifications and postural techniques such as a chin tuck position.[28] Some maneuvers may serve as a compensatory strategy and function as rehabilitative exercises, such as the effortful swallow, supraglottic swallow, super-supraglottic swallow, and the Mendelsohn maneuver.[28] Other exercises, such as the Shaker exercise and Masako maneuver, may improve swallowing physiology. Tactile, thermal, or sour taste stimulation and noninvasive neurostimulation therapies are also used.[28]

Swallowing therapies in survivors up to six months after stroke may reduce the length of hospital stay, dysphagia, chest infections, and swallowing ability.[28] However, they do not significantly affect mortality, dependency/disability, and case fatality outcomes.[28]

A randomized trial[29] demonstrated significant recovery from dysphagia, prevention of aspiration pneumonia, and reduced time to return to oral feeding in participants who initiated swallowing therapy in the first 48 hours and during the first 3 days compared with a delayed dysphagia program in rehabilitation.

Non-invasive neurostimulation therapies, such as rTMS, tDCS, and surface neuromuscular electrical stimulation provide benefits regarding performance in heterogeneous swallowing tests.[30,31] However, the number and quality of the studies were relatively limited. Statistical heterogeneity was moderate, high, or not reported in some of the published meta-analyses[30,31] about the effects of these interventions in post-stroke dysphagia. Phase-3 clinical trials are required. There is no benefit with pharyngeal electrical stimuation.[32]

Recommendations

- Early swallowing therapies are recommended for recovery from dysphagia (Recommendation I-A);
- Dysphagia screening should be performed early after stroke to prevent aspiration pneumonia, malnutrition, and dehydration (Recommendation I-B);
- Surface neuromuscular electrical stimulation, rTMS, and tDCS are under investigation, but evidence about their clinical effectiveness is not well established (Recommendation IIb-A);
- Videofluoroscopy and fiberoptic endoscopic evaluations can be performed if aspiration is suspected without clinical symptoms or signs (Recommendation IIa-B);
- Pharyngeal electrical stimulation is not recommended to improve dysphagia after stroke (Recommendation III-A).

POSTURAL CONTROL AND BALANCE

Changes in balance and postural control are caused by motor impairment and loss of sensory and spatial orientation of the body. They are common after stroke and negatively affect the quality of life, activities, and participation of individuals.[33]

Trunk training, with support, on unstable surfaces, such as balls used in physical therapy sessions, air mattresses, pillows, and boards, appears to be superior to stable surfaces to improve static and dynamic balances.[34] There is strong evidence of the benefits of trunk control training in sitting as well as mobile and static balances.[35]

Two systematic reviews with meta-analyses showed that virtual reality on its own[36] and virtual reality associated with conventional physiotherapy[37] effectively improved post-stroke balance. Despite limited evidence, telerehabilitation, combined with virtual reality, for balance training, can be an alternative to overcome difficulty in accessing a rehabilitation service.[38]

Hydrotherapy significantly improved postural balance, more so in chronic patients than in patients in the subacute phase.[39] Aerobic exercise on a cycle ergometer has no positive effect on balance.[40,] However, the effects of treadmill gait training, with or without weight support, have been found to be positive.[41] Peripheral somatosensory stimulation was beneficial in controlling postural stability in individuals in the poststroke chronic phase as an adjuvant therapy.[42] A meta-analysis[43] showed that robot-assisted gait training improved balance when compared with the absence of this intervention, despite the limitations of the analyzed studies.

The effects of mental imagery, rTMS, and tDCS are controversial due to the methodological variability in the studies.[44–46]

Functional task-training associated with musculoskeletal intervention and/or cardiopulmonary intervention and sensory interventions seem to be effective in improving balance and postural stability respectively.[47] However, the heterogeneity of physical therapy and the weak methodological quality of studies limited the interpretation and the confidence in findings.[47] The physical therapy techniques evaluated in this meta-analysis[47] included balance training, walking, transfers, getting up and down activities, reaching objects with upper limbs (ULs), active muscle strengthening, active-assisted and passive cardiopulmonary fitness, and sensory interventions such as thermal, tactile, visual, and vestibular stimulation.

Recommendations

- Training with specific exercises for balance, on different surfaces, unilateral weight bearing, and gait training are recommended (Recommendation I-A);
- Methods using hydrotherapy and aquatic exercises are recommended (Recommendation I-A);
- Virtual reality is recommended to improve poststroke balance (Recommendation I-A);
- Task-specific physiotherapy techniques associated with interventions for cardiovascular conditioning, skeletal muscle, and sensory stimulation should be employed (Recommendation IIa-A);
- Treadmill training, with or without partial weight bearing, and robot-assisted gait training should be used (Recommendation IIa-A);
- Peripheral somatosensory stimulation may be used as an adjuvant therapy (Recommendation IIb-B);
- The mental practice technique is controversial (Recommendation IIb-B);
- The effects of tDCS and rTMS are uncertain (Recommendation IIb-A);
- Aerobic exercises on a cycle ergometer, for balance improvement and postural control, are not effective (Recommendation III-A).

ATAXIAS

The term ataxia refers to a disturbance in voluntary movement present in cases of injury or damage to the cerebellum, cerebellar peduncle, and cerebellar pathways of the brainstem.[48] Ataxia, present in 2% to 3% of patients after stroke, is a loss of coordination, dysmetria, dysarthria, hypotonia, rebound phenomenon, and nystagmus.[49]

There are few intervention studies on ataxia in stroke patients. Case studies indicate that task training with specific goals can improve limb ataxia in poststroke individuals, and rTMS is still in the experimental phase.[50]

Recommendations

- Task training, with specific goals, can be used in poststroke ataxia (Recommendation IIb-C);
- Repetitive transcranial magnetic stimulation is still in the experimental phase and should not be routinely used in the treatment of post-stroke ataxia (Recommendation III-C).

SPASTICITY

The prevalence of poststroke spasticity (PSS) ranges from 20% to 40%.[51] Loss of movement control, abnormal posture, increased muscle tone, painful spasms, and an overall decline in muscle function are the main symptoms.[51] Changes in the passive properties of muscles may lead to contractures.[51]

The clinical assessment methods most commonly used include the Modified Ashworth Scale (MAS) and the Modified Tardieu Scale (MTS).[52]

A combination of rehabilitation techniques and pharmacological and non-pharmacological interventions produces better effects.[53]

Baclofen, tizanidine, and oral benzodiazepines, which are commonly used in daily practice, still lack good evidence for their use, with frequent adverse effects, especially in elderly patients.[54]

There is sufficient evidence to conclude that botulinum toxin is safe and effective in reducing UL and lower-limb spasticity after stroke.[55] However, the effect on motor function remains unclear.[56] A meta-analysis[57] showed improvement in impairment, but no significant effect on gait speed. A recent consensus of specialists[58] in the treatment of poststroke spasticity with botulinum toxin recommended an approach based on three key areas: individualized intervention, optimal injection technique and preparation of the toxin, and rehabilitation with adjuvant therapies concomitant with and after the injection of botulinum toxin.

Severe forms of PSS can be treated with intrathecal baclofen.[59]

Among the non-pharmacological approaches, kinesiotherapy[60] and functional bandaging (taping)[61] can be considered. Splints and orthoses have uncertain benefits.[62] Transcutaneous electrical nerve stimulation (TENS) and functional electrical stimulation (FES) reduce spasticity in the lower limbs.[63,64] Acupuncture and electroacupuncture combined with conventional routine care may be beneficial for PSS.[65]

Recommendations

- The application of botulinum toxin to target muscles is recommended for the treatment of spasticity (Recommendation I-A);
- Transcutaneous electrical nerve stimulation is recommended to reduce muscle spasticity in the lower limbs (Recommendation I-A);
- Functional electrical stimulation of spastic muscles can be considered (Recommendation IIa-A);
- Treatment with intrathecal baclofen can be used in refractory cases (Recommendation IIa-A);
- Acupuncture, electroacupuncture, and functional bandaging should be considered (Recommendation IIa-A);
- Kinesiotherapy may be considered in the treatment of spasticity (Recommendation IIb-B);

- Oral medications such as baclofen, tizanidine, and benzodiazepines may be used, always considering their adverse effects (Recommendation IIb-A);
- The effects of botulinum toxin on function are uncertain (Recommendation IIb-A);
- Splints and positioning orthoses have uncertain effects (Recommendation IIb-A).

UPPER LIMB

The UL is affected in 80% and 40% of patients in the acute and chronic phases after stroke respectively.[66] Impairments of the UL chronically limit functional independence and satisfaction in 50% to 70% of stroke patients. Weakness, hypotonia, hypertonia, joint instability, and loss of motor control cause functional limitations in reaching, grasping, and manipulating objects.[66]

Although extensively used in rehabilitation, there is limited evidence favoring the Bobath approach.[67] Strength training can improve UL strength and function without increasing tone or pain.[68] Resistance training is superior to other therapies for muscular strength and motor function.[69] There is no evidence that stretching therapy improves UL motor impairment and disability.[66]

Although a previous meta-analysis suggested that constraint-induced movement therapy (CIMT) might be superior to traditional rehabilitation, the most recent Cochrane review[70] indicated that CIMT was associated with limited improvement in motor impairment and function, but these benefits did not reduce disability. However, another meta-analysis[71] showed significant benefits of CIMT in patients with acute or subacute stroke.

Biofeedback may have some beneficial impact, according to low-quality evidence.[72] There is evidence of the effectiveness of mirror therapy in improving upper extremity motor function, motor impairment, activities of daily living, and pain,[73] in association with other conventional rehabilitation therapies for stroke patients.[74] Mental practice (MP) effectively reduces the limitations to UL activity after stroke, particularly in the first three months and in individuals with severe UL dysfunction.[75] Bilateral and unilateral UL training improved motor impairment and functional performance after stroke; however, bilateral training was superior in terms of improving motor impairment.[76]

Although some studies have shown positive effects with repetitive peripheral sensory stimulation (RPSS),[77] tDCS,[78] and rTMS,[79] these techniques are still under investigation.

When initiated within two months of the stroke, FES is a promising therapy for UL recovery.[80] However, the very low quality of the evidence analyzed means that a clear conclusion about its effects cannot be established. Robot-assisted therapy promotes the use of the affected limb, intensifies rehabilitation through task repetition, and offers task-specific practice.[81] Virtual reality (VR) provides augmented feedback and preserves motivation.[82] A common denominator of VR systems and robot-assisted therapy is playful intervention by means of serious games.[83] A serious game is defined as a game that has education or rehabilitation as its primary goal.[84] These games combine entertainment, attentional engagement, and problem solving to challenge function and performance.[84] After a case of stroke, VR for the UL appears to be more effective than the conventional methods,[85] and it may be beneficial when used as an adjunct to usual care. Upper-limb rehabilitation through serious games showed more improvement when compared with the conventional treatment, and long-term effect retention was maintained for UL function, but heterogeneity was high.[86] Robot-assisted therapy might be superior to conventional rehabilitation in improving severe UL motor impairment in stroke patients with hemiplegia and limited potential for spontaneous recovery.[87]

There is insufficient evidence to support the efficacy of methylphenidate, trazodone, levodopa, and nortriptyline in UL recovery after stroke.[66] Fluoxetine for six months did not improve functional outcomes and increased the risk of bone fractures.[88,89] Although not specific to UL, a recent guideline presented a weak recommendation for cerebrolysin (30 mL intravenously for at least ten days) and citalopram (20 mg) to promote early motor neurorehabilitation after acute ischemic stroke.[90]

Recommendations

- Techniques to strengthen the UL are recommended to improve UL recovery after stroke (Recommendation I-A);
- Mirror therapy, MP, and unilateral and bilateral training for UL rehabilitation after stroke can be beneficial (Recommendation IIa-B);
- Virtual reality should be considered an adjuvant therapy for UL recovery after stroke (Recommendation IIa-B);
- Serious games can be useful in UL rehabilitation after stroke (Recommendation IIa-B);
- Robot-assisted therapy can be indicated in severe UL motor impairment poststroke (Recommendation IIa-A);
- Constraint-induced movement therapy can be used in UL rehabilitation after stroke (Recommendation IIa-A);
- Biofeedback can be useful for UL recovery after stroke (Recommendation IIa-B);
- The effect of stretching therapy is not well established (Recommendation IIb-B);
- The effectiveness of FES for UL improvement after stroke is unclear (Recommendation IIb-B);
- Repetitive peripheral sensory stimulation, tDCS, and rTMS for UL rehabilitation are under investigation, but evidence about their clinical effectiveness is not well established (Recommendation IIb-A);
- The benefits of the Bobath approach are uncertain (Recommendation IIb-C);
- Cerebrolysin and citalopram may be considered in early motor rehabilitation after acute ischemic stroke (Recommendation IIb-A);
- Methylphenidate, trazodone, levodopa, and nortriptyline are not recommended to enhance UL recovery after stroke (Recommendation III-B);
- Fluoxetine should not be used for motor rehabilitation (Recommendation III-A).

MOBILITY

Limitations to mobility and activities related to gait are some of the most impacting sequelae of stroke. More than 20% of stroke survivors do not walk independently, and even if they achieve independence, most have difficulty ambulating in their communities.[91]

An exercise program that combines cardiorespiratory training, to enhance cardiorespiratory fitness, and resistance training could promote greater walking speed, muscle strength, balance, and walking endurance.[92]

Circuit class therapy (CCT) is superior to conventional therapy in improving mobility, independence, and gait speed in stroke patients.[93] The potential risk of falls should be considered.[93]

Rhythmic auditory cueing enhances gait performance, dynamic postural stability, stride length, and cadence.[94]

Water-based exercises may improve muscle strength, balance, mobility, and aerobic capacity compared with land-based exercises.[95]

Improvement in the ability to walk independently with treadmill training (TT), with or without body weight support, was not superior when compared with no TT, but walking speed and walking endurance improved slightly in the short term.[96] The effects were more significant, though not persistent, for those who were able to walk.[96] Better recovery of walking speed and distance in ambulatory patients was observed with TT.[97]

Gait in electromechanical-assisted training associated with physiotherapy after stroke promotes a greater chance of achieving independent walking than physiotherapy without these devices.[98] Three months after stroke, participants who were not ambulatory seemed to benefit most from this type of intervention.[99] Repetitive gait training within the first three months poststroke can lead to long-term functional improvements if provided with an end-effector robot.[100]

When compared with conventional therapy approaches, VR and interactive game training did not produce statistically significant changes in regarding improvements in gait speed or balance.[85]

Compared with placebo or no intervention, there is no evidence of superiority in gait, motor function, and functional mobility after stroke from motor imagery.[101]

The Bobath approach was not superior in terms of regaining mobility, motor control of the lower limb and gait, balance, and activities of daily living of poststroke patients when compared with other interventions.[67]

No differences in motor function were observed between real acupuncture and sham acupuncture after stroke.[102]

Stroke patients may require an assistive technology device to aid in mobility. These comprise orthoses, splints, wheelchairs, walkers, and crutches.

Ankle–foot orthosis (AFO) is recommended to position the ankle during gait to prevent foot drop injury and to improve gait kinetics and kinematics of both the knee and ankle joints in poststroke gait.[103] There are two AFO models: fixed AFOs are recommended for patients who demonstrate great ankle instability during gait, and articulated AFOs are indicated for patients with greater stability of the ankle joint.[104,105] The AFO can improve ankle and knee kinematics, kinetics, and the energy cost of walking in stroke survivors.[104] However, no convincing evidence has been observed regarding walking speed.[105] A decrease in energy expenditure during gait with AFO was also observed.[106]

Ankle joint stabilization improves with FES of the foot dorsiflexors.[107] It consists of a structure with different presentations in which plantar sensors are connected to superficial electrodes that promote the contraction of the tibial and dorsiflexor muscles, preventing foot drop during the swing phase of gait.[107] A meta-analysis[108] concluded that there was evidence that AFO and FES can increase gait speed, mobility, dynamic balance, quality of life, endurance, and muscle activation poststroke. Another meta-analysis[109] of low-quality evidence showed that FES applied to the paretic peroneal nerve, when combined with physiotherapy, can improve ankle dorsiflexion, balance, and functional mobility.

The benefits of walking with a cane poststroke are uncertain. A comparative study of the effect of a simple cane and a four-point cane in individuals three months after a stroke showed that the use of a cane improves gait symmetry, which is indicated for patients at the beginning of gait training.[110] However, despite the methodological limitations of the studies, a systematic review[111] showed no improvement in gait parameters concerning speed, step length, cadence, and symmetry after stroke with a single support cane. There was a slight reduction in speed with a four-point cane compared with the gait without a mobility device.[112]

Walkers can help gait in patients with balance deficits, but weakness in the UL or the inability to use the hand to grasp the walker is a limitation to their use. When comparing the use of a simple cane with a four-point cane and walkers, it was observed that the energy spent in gait in individuals who used a walker was higher.[113]

Mobility devices such as wheelchairs, walking sticks, and bath chairs are associated with greater independence after a stroke.[113]

Recommendations

- An exercise program, including cardiorespiratory and resistance training, should be used to improve gait after stroke (Recommendation I-A);
- Circuit class training is recommended for walking and balance recovery poststroke (Recommendation I-A);
- Functional electrical stimulation can be useful in improving ankle dorsiflexion, balance, and functional mobility (Recommendation IIa-B);
- It is reasonable to use AFO in gait rehabilitation after stroke (Recommendation IIa-A);
- Gait performance, dynamic postural stability, stride length, and cadence can be improved with rhythmic auditory cueing (Recommendation IIa-A);
- Water-based exercises can be recommended for gait rehabilitation after stroke (Recommendation IIa-B);

- Treadmill training, with or without body weight support, can improve speed and walking endurance poststroke, and is reasonable to use (Recommendation IIa-B);
- Electromechanical-assisted gait added to physiotherapy can be beneficial for gait recovery, mainly in the first three months poststroke, and for participants who are not able to walk. (Recommendation IIa-B);
- The benefits of VR, interactive games, mental imagery, and the Bobath approach are not well established (Recommendation IIb-A);
- Ankle–foot orthoses can be used in patients with poststroke foot drop (Recommendation IIa-A);
- Functional electrical stimulation of the dorsiflexor muscles should be considered to improve gait and ankle positioning (Recommendation IIa-A);
- Wheelchairs can be used to promote greater levels of independence after a stroke (Recommendation IIa-C);
- The benefits of walking devices and canes to support gait after stroke are uncertain (Recommendations IIb-B);
- Acupuncture is not useful for gait recovery after stroke (Recommendation III-A).

COGNITION

Poststroke cognitive deficits occur early and are quite frequent, as they appear within the first 3 months in up to 55% of patients when at least 1 cognitive domain is considered.[114] Poststroke dementia occurs when there is cognitive decline immediately after or within the first six months after vascular ictus, with no evidence of improvement in this period.[115] Since an informal clinical evaluation may underdiagnose cognitive decline, the use of test that have already been validated is recommended.[116] No superiority was observed among the tests that assess cognition.[117]

Reducing the levels of systolic blood pressure is effective in decreasing the incidence of poststroke cognitive deficit.[118] The use of statins shows conflicting results.[119] Donepezil and galantamine may be useful to improve poststroke cognition, but the benefits of memantine and rivastigmine are not well established.[120]

Evidence[121] suggests that physical activity is an intervention with a protective role that may improve poststroke cognition. In addition, it is a low-cost strategy with a positive impact on motor function, quality of life, and cardiopulmonary condition.[122]

Cognitive rehabilitation has shown benefits, improving poststroke memory and attention, but with limited conclusions regarding its efficacy due to the quality of the studies published.[123] The association between cognitive and physical rehabilitation seems to provide greater benefits than isolated therapies.[124] Studies[125] with VR are isolated, but show promising results. A meta-analysis[126] of four systematic reviews on poststroke cognitive impairments showed that acupuncture is safe and improves cognitive function without serious adverse events in stroke patients.

Repetitive transcranial magnetic stimulation and tDCS are still in an exploratory stage.[127] There is no evidence to recommend neurofeedback in poststroke cognitive rehabilitation because of the limitations of the studies evaluated.[128]

Recommendations

- Cognition assessment poststroke with validated tests is recommended (Recommendation I-B);
- Systolic pressure reduction is recommended to prevent poststroke cognitive deficits (Recommendation I-A);
- Acupuncture associated with cognitive rehabilitation can be employed (Recommendation IIa-A);
- Physical activity should be employed as an adjunctive treatment in the rehabilitation of poststroke cognitive deficits (Recommendation I-A);
- Donepezil and galantamine may be beneficial for patients with poststroke mixed dementia (Recommendation IIa-A);
- The association of cognitive rehabilitation with physical rehabilitation may be beneficial (Recommendation IIa-C);
- The benefits of memantine and rivastigmine have not been established (Recommendation IIb-A);
- Cognitive rehabilitation strategies for memory may be used, but the benefits are uncertain (Recommendation IIb-C);
- Neuromodulation and neurofeedback techniques are still under investigation, and should not be used routinely (Recommendation III-C).

UNILATERAL SPATIAL NEGLECT

The non-recognition of space, usually on one side of the body, or of any stimulus applied to it, is called hemineglect syndrome or unilateral spatial neglect (USN),[129] and it designates a consistent, exaggerated spatial asymmetry in processing information in bodily and/or extrabodily space due to an acquired cerebral lesion, which cannot be explained by primary motor or sensory deficits. The processing of neglected information can occur implicitly, without reaching consciousness, and can influence task performance.[129]

Unilateral space neglect occurs in $\sim$ 50% of individuals after right-hemisphere stroke, and it may persist in 75%, with some symptoms, in the chronic phase.[130] Patients with neglect are often unaware of or fail to acknowledge items on their contralesional side and attend instead to items on the same side as their brain damage—their ipsilesional side.[130] Unilateral space neglect causes prolonged hospitalization, impaired functional recovery, and reduced quality of life.[131]

Several rehabilitation methods have been developed to improve spatial neglect in the last few decades. These can be classified according to their theoretical basis:[132] 1) enhancing awareness of neglect behavior through a top-down mechanism; 2) low-level bottom-up sensory stimulation; and 3) neuromodulation.

Top-down treatments consist of training the gaze direction using cues from the patient's left side. Videos to show the patient their omissions during recorded functional tasks and mental images can also be used. However, these methods are limited because they require attention skills, which can be hampered by the lack of awareness of spatial neglect behaviors, such as anosognosia.[132]

Bottom-up treatments, including prismatic adaptation, visual scanning training, optokinetic stimulation, VR, limb activation, neck vibration combined with prism adaptation, voluntary trunk rotation, and vestibular rehabilitation improve immediate and long-term performance in USN.[132,133]

Moderate-quality evidence showed that rTMS was more efficient than sham for USN after stroke.[134] Repetitive transcranial magnetic stimulation in the posterior parietal cortex, and theta-burst stimulation, improved USN after stroke.[135] Very low-quality evidence suggested that tDCS has a beneficial effect in improving USN after stroke.[136]

Recommendations

- Repeated "top-down" and "bottom-up" interventions can be considered, such as prismatic adaptation, visual scanning training, optokinetic stimulation, VR, limb activation, motor imagery, voluntary trunk rotation, vestibular rehabilitation, and vibration of the neck combined with prismatic adaptation to improve USN after stroke (Recommendation IIa-A);
- The benefits of tDCS and rTMS to reduce USN after stroke are uncertain (Recommendation IIb-A).

SENSORY IMPAIRMENT (HEARING, VISION, AND TOUCH)

Sensory impairment after stroke, including hearing, vision, touch, and proprioception, is directly linked to activity limitations and participation restrictions.[137] However, they can improve with therapeutic intervention, particularly multimodal interventions.[138]

Hearing loss of a vascular cause is usually associated with cerebellar infarction in the territory of the anterior inferior cerebellar artery.[139] The incidence of hearing loss in stroke patients is twice as high as that of non-stroke individuals, and it can limit participation in rehabilitation programs.[140]

Approximately 20% of stroke survivors report severe difficulties with speech recognition in the presence of background noise, despite normal audiometry.[141] Hearing loss is usually treated with a personal frequency-modulated (FM) system with meaningful benefits.[142] A prospective, nonrandomized, controlled study in stroke patients showed clinical improvements in the speech reception threshold with the use of a personal FM system.[143]

Visual impairment after stroke has a prevalence of 73% in the acute stroke population.[144] The four most impaired visual functions are reduced central vision, loss of the peripheral visual field, eye movement disorders, and visual perception disorders.[145]

For the treatment of visual loss, prism lenses, unilateral eye occlusion, adapted lighting, picture amplification, environment modification, orthoptic exercises, Fresnel prism, verbal, written, and head posture advice have been employed.[146] The evidence for all these interventions is weak, and there is a lack of evidence relating to their effect on functional ability in activities of daily living.[146]

One in two individuals who had a stroke had reduced sensation, impacting both the ability to function independently and the overall quality of life.[147] In acute ischemic stroke, almost 60% of patients showed somatosensory impairment in at least one subitem in the acute stage, but there is considerable recovery over time. Reduced sensation is associated with reduced motor function in terms of quality of movement control, and lesser rehabilitation outcomes.[148]

Sensory rehabilitation, which triggers the activation of the cutaneous nerves, can be performed with somatosensory afferents, such as thermal, pressure, peripheral nerve, transcutaneous electrical nerve, and vibration stimulations.[149] Additionally, a sensory retraining approach based on graded re-education using learning principles and augmenting sensory input, such as proprioception, tactile recognition, desensitization, stereognosis, location, and discrimination is another option for sensory stimulation. Additionally, with haptic-based augmented reality, feedback devices that augment targeted sensory afferents can be used.[149]

Systematic reviews and meta-analyses have shown that a varied range of intervention methods intended for retraining leg somatosensory function after stroke effectively improves somatosensory impairment and balance, but not gait.[150] A systematic review showed that somatosensory retraining may assist people in regaining somatosensory discrimination skills in the arm after stroke.[151]

Recommendations

- Frequency-modulated systems are recommended for hearing loss after stroke (Recommendation I-B);
- Leg somatosensory retraining can be used to improve balance after stroke (Recommendation IIa-A);
- Arm somatosensory retraining can improve somatosensory discrimination skills after stroke (Recommendation IIa-A);
- Prism lenses, unilateral eye occlusion, adapted lighting, picture amplification, environment modification, orthoptic exercises, Fresnel prism, verbal, written, and head posture advice may be used for visual impairment after stroke (Recommendation IIb-C).

REHABILITATION CONTINUITY: HOME REHABILITATION, RETURN TO LEISURE, WORK, AND DRIVING

Home rehabilitation (HR) should be part of the ongoing rehabilitation planning, according to a meta-analysis.[152] Well-established and early HR resulted in a better quality of life.[152]

Resistive reach and grip exercises in the home environment showed positive results in the activity level of the ULs.[153] Home mirror therapy associated with repetition training and activities of daily living can result in better responses in motor activity and in the sit-and-stand test.[154] Visuomotor feedback training at home was an effective method to improve USN.[155] In poststroke home treatment, VR was beneficial for UL mobility.[156] Home rehabilitation with glove therapy and fingertip sensors with visual feedback on a screen according to the movements performed improved hand movement compared with conventional treatment in HR.[157] Home caregivers promoted positive results for poststroke physical function and depressive symptoms.[158]

Stroke patients have been shown to have difficulties participating in leisure and recreational activities.[152] Recreational activity programs improved physical and mental function.[159]

Less than 50% of poststroke patients can return to work 6 months post-stroke and 50% have deficiencies in performing work activities 5 years after the event.[160] Intervention in the work environment promoted a higher percentage of return to work.[160] Occupational rehabilitation interventions have shown positive effects on accommodation to the environment and job satisfaction.[161]

After a stroke, drivers may have compromised reflexes, leading to risks behind the wheel, with a consequent increase in the chances of collisions, excessive speed, and invasion of the opposite lane.[162] Although the effects of rehabilitation on poststroke return to steering are uncertain, the use of a rotary knob in steering in a specific position and driving simulators can be used as tools for a return to driving activity after stroke.[163]

Recommendations

- Early planned HR is recommended for poststroke recovery (Recommendation I-A);
- Resistance exercises involving reaching and gripping with the ULs should be included in the HR (Recommendation I-A);
- It is recommended that caregivers be educated to help patients' physical and emotional recovery at home (Recommendation I-A);
- The combination of rehabilitation with mirror therapy and specific training can be used in HR (Recommendation IIa-B);
- Virtual reality and gloves with sensors on the fingers associated with visual feedback can be used in HR (Recommendation IIa-B);
- Poststroke patients should receive guidelines for recreational activities (Recommendation IIa-B);
- Interventions in the workplace must be available to facilitate poststroke return to work (Recommendation IIa-B);
- Adaptations in motor vehicles and driving simulators can be used for poststroke patients (Recommendation IIa-B).

MEDICATION ADHERENCE

Medication adherence is defined as "the extent to which a person's behavior when using medications corresponds with the agreed recommendations from a health care provider".[164] Five dimensions and two factors influence adherence behavior. The five dimensions are the patient, the health system, socioeconomic status, therapy, and health status. The factors are classified as intentional, such as skipping a dose of the drug when considering that the symptoms are under control, and unintentional, such as skipping a dose due to forgetfulness.[164]

Limitations to the adherence to medications affect $\sim$ 50% of poststroke individuals.[165] Patients with atrial fibrillation and greater adherence to oral anticoagulants have a lower risk of stroke, transient ischemic attack, and mortality.[165] Better adherence to statins and antihypertensives is also associated with a lower risk of stroke.[166] On the other hand, non-adherence is associated with a greater chance of recurrence, mortality, long-term disability, and dementia.[167]

Better medication adherence is associated with better knowledge of medications and the need to use them.[168] Although promising, the use of automated telecommunication interventions, including text messages and interactive voice response, showed conflicting results in two meta-analyses[168,169] that analyzed medication adherence for secondary prevention of cardiovascular disease. Intervention with telephone support, conducted mainly by nurses, can be effective.[169]

Medication adherence improved after self-management interventions to better control risk factors in poststroke individuals.[170] Interventions based on cognitive and behavioral orientation, such as simplifying the act of taking medications, environment reminders, and information to improve drug treatment beliefs, improved medication adherence after stroke.[170]

Recommendations

- Interventions based on cognitive and behavioral orientation should be conducted to improve medication adherence (Recommendation I-A);
- Self-management interventions to control risk factors may be beneficial to improve poststroke medication adherence (Recommendation IIa-A);
- Information about medications and their use is recommended to improve medication adherence after stroke. (Recommendation I-B)
- Telephone calls can be effective in improving medication adherence (Recommendation IIa-A);
- The benefits of telecommunication are uncertain (Recommendation IIb-A).

PALLIATIVE CARE

Neurological palliative care (PC) has become increasingly important and relevant in studies worldwide. Considering that it is comprehensive, multidisciplinary care, it makes perfect sense to apply it to patients with neurological diseases, especially those affected by stroke, to alleviate and prevent the suffering of people with serious, life-threatening diseases.[171]

Palliative care should be initiated early in stroke patients, not only when the patient is close to death.[172] All patients who have suffered a stroke and have reduced quality of life and life expectancy, as well as their families, should have access to PC.[173] Ideally, PC should be provided by the neurology or Intensive Care Unit (ICU) team and by a PC service at the time of diagnosis.[173]

There are three possible models for the integration of neurological care and PC.[173] The first one is the consultative model, through an exceptional evaluation via consultation with the PC team. The second one is the integrated model, in which the teams work together simultaneously. The third one is primary neuropalliative care, in which the neurologist is trained to provide primary PC and determine when there is a need for referral to a specialized team.

In the last model, neurological PC provides greater involvement, as the neurologist who follows the patient since the diagnosis has a stronger connection and more data to predict and define a therapeutic plan.[173]

The main contributions of the neurologist in primary PC, which can be useful for every professional involved in the care of the patient, are recognizing the PC needs associated with each neurological disease, identifying and treating pain, providing basic psychosocial and spiritual support, acquiring communication skills (including empathic listening), evaluating the prognosis, supporting patients and families regarding tragic choices, being aware of last-resort PC options, and acknowledging and managing the caregiver's distress and needs.[172]

Neurologists should also know how to identify an indication for specialized (or secondary) PC, which includes management of refractory and complex physical symptoms, management of complex psychological and spiritual suffering, assistance in conflict resolution in relation to the objective and treatment options, transfer to hospice, and end-of-life management.[173]

Recommendations

- Palliative care is recommended for people with stroke in cases of reduced quality of life and reduced life expectancy (Recommendation I-C);
- Palliative care should be provided by neurologists, the ICU team, and the PC Service at the time of diagnosis (Recommendation I-B);
- Formal assessment of PC should be recommended in end-of-life situations, in the presence of refractory pain, dyspnea, agitation, mood disorders, long-term feeding assistance, ventilation, palliative extubation, and assistance in resolving conflicts between family members and health teams (Recommendation I-B).

CEREBROVASCULAR EVENTS RELATED TO SARS-COV-2 INFECTION

Infection by severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2) has been heavily associated with short- and medium-term neurological complications.[174] These conditions increase the risk of headache, encephalopathy, epileptic seizures, delirium, and cerebrovascular events such as ischemia, intracranial hemorrhage, central venous thrombosis, and subarachnoid hemorrhage.[174] The incidence of cerebrovascular disease in patients with active SARS-Cov-2 infection ranges from 2.3% to 6%, and it is higher among patients with more severe infection.[174] One study[174] reported that central venous thrombosis occurred in 0.3% of cases, and infection increased the frequency of involvement of multiple cerebral arterial territories, with more extensive lesions and subsequent greater neurological severity. At the same time, younger people were more affected than controls.[174]

The coronavirus disease 2019 (COVID-19) pandemic has radically changed processes, patient access, and stroke care. However, the nature and quality of stroke care across the entire service line have proven benefits in long-term results.[175] Standards and scope in the care of stroke patients must be maintained; otherwise, the recurrence rate of stroke and ongoing disabilities in general will increase and generate a new burden on an already overloaded service network. Overall, measures to preserve the best stroke management practices must be implemented in the context of the pandemic across the health system. Alternative care models such as telerehabilitation may provide greater access to care for stroke patients during the COVID-19 pandemic.[175] However, the literature is still scarce, and robust evidence on stroke rehabilitation related to SARS-CoV-2 infection is lacking.

Recommendations

- Rehabilitation strategies must comprise a multidisciplinary approach focusing on neurological impairments and disabilities after stroke that is related to SARS-CoV-2 infection (Recommendation IIb-C);
- Access to specialized centers such as stroke units, outpatient care, early support on discharge, and community stroke rehabilitation might be considered for stroke related to SARS-CoV-2 (Recommendation IIb-C).

FUTURE OF STROKE REHABILITATION

The flourishing of rehabilitation science has broadened knowledge about the heterogeneity of plasticity and recovery mechanisms in different individuals and poststroke phases.[176] To develop clinically-relevant strategies, solid bridges need to be built between studies in animals, proof-of-concept studies, randomized clinical trials in different phases, pragmatic studies, good-quality meta-analyses, and the practical needs of the patients, their families, professionals, and health services. In recent years, studies such as EXCITE, FLAME, FOCUS, and AVERT (for a review, please check the study by Cramer[177]), among others, have shown that it is possible to test rehabilitation interventions and understand that patient characteristics are crucial for choosing therapies with a greater likelihood of success. "Precision rehabilitation" with realistic and individualized goals can thus be implemented.

With this approach, it becomes crucial to define "the right therapy for the right patient at the right time". Consensus on outcomes to be used in rehabilitation research, advances in neurophysiology techniques, structural and functional neuroimaging, genetics, data science, and artificial intelligence (AI), recognition of the importance of interdisciplinary work, patient opinions or preferences regarding the goals of the rehabilitation process, as well as the involvement of patients in this process, have contributed to increasing innovations.[178,179] Among the techniques that may be included in poststroke rehabilitation in the future, for example, through the enhancement of adaptive mechanisms of plasticity, are the use of drugs, non-invasive brain-computer interface (NIBCI), and behavioral interventions.[180]

Social isolation during the COVID-19 pandemic underscored the need to develop telerehabilitation tools that use strategies such as videoconferencing to supervise rehabilitation activities. A study[179] compared this intervention with the same rehabilitation protocol applied in an out-of-home environment and observed an improvement in the levels of disability, balance, and stress of the caregiver without distinctions among groups. Telerehabilitation may be effective for motor rehabilitation and is less costly than conventional therapy.[178] Technological advances may increase the effectiveness of different telerehabilitation techniques and leverage other promising perspectives such as NIBCI,[180] wearable sensors,[181] devices for communication in critically-ill patients,[182] feedback and motivation systems,[183] and interactive robots,[184] among others. Despite many exciting possibilities, there is still a gap between research and the daily practice. For the design, testing, and implementation of useful strategies in the practice, it is essential that networks bring together researchers and rehabilitation professionals so that multicenter studies can be performed by considering the needs and opportunities in local, regional, or national cost-effectiveness contexts. Interventions that work in other countries may not work well in Brazil, and vice versa. Facilitators and barriers to rehabilitation can be very different in a large urban center and a small town in the heart of the Amazon. Access to rehabilitation after stroke in different Brazilian regions has been evaluated by the Access to Rehabilitation after Stroke (AReA) study.[185] Therapies based on new technologies do not always result in clinical benefits and are sometimes accompanied by costs that make them unaffordable for many. Therefore, it is crucial to choose evidence-based rehabilitation interventions suited for our reality. By doing so, we will be able to drastically impact the quality of life of millions of people with stroke.

SUGGESTED SITES FOR PATIENTS AND CAREGIVERS

- Ação AVC: http://www.acaoavc.org.br
- Associação Brasil AVC: https://abavc.org.br
- Orientações Multidisciplinares para Pacientes Pós AVC – UAVC HCFMB-UNESP: https://drive.google.com/file/d/1UUoYNR7jcPkgbH5SK3hWLypofYSKmK2W/view
- Rede Brasil AVC: http://www.redebrasilavc.org.br
- American Stroke Association: https://www.stroke.org/
- Heart and Stroke Foundation-Canadian Partnership for Stroke Recovery: http://www.canadianstroke.ca/
- The Internet Stroke Center: http://www.strokecenter.org
- World Stroke Organization: https://www.world-stroke.org

CONCLUSIONS

The field of rehabilitation is open to incorporating new interventions to enhance the practice and the care after stroke. There have been significant breakthroughs in the last two decades through randomized controlled trials on stroke rehabilitation. High-level evidence supports the following recommendations: early speech, language, and swallowing therapy; specific training exercises for balance; botulinum toxin to reduce spasticity; mirror therapy; mental practice; unilateral and bilateral training; strengthening of upper limb improvement; cardiorespiratory and resistance training for gait recovery; physical activity as an adjunctive treatment to cognitive decline; and home planned rehabilitation after stroke. Future research is needed to establish the role of new technologies, such as neuromodulation, robotics, VR, and telerehabilitation as a routine in the clinical practice.

Supplementary material is avalilable online.

Authors' Contributions

Introduction – CM, RZ: conceptualization, writing, review, editing, and validation of the original draft. Disorders of communication: aphasia, dysarthria, and apraxia of speech – LIZM, KZO: conceptualization, writing, review, editing, and validation of the original draft; MCL: participation as reviewer. Dysphagia – PWT: conceptualization, writing, review, editing, and validation of the original draft. Postural control and balance – LAPSS: conceptualization, writing, review, editing, and validation of the original draft; ROC: participation as reviewer. Ataxias – LAPSS: conceptualization, writing, review, editing, and validation of the original draft; ROC: participation as reviewer. Spasticity – CM: conceptualization, writing, review, editing, and validation of the original draft; MCL: participation as reviewer. Upper limb – CM, ABC, ROC: conceptualization, writing, review, editing, and validation of the original draft. Mobility – ROC, DMCC, RDMC, CM: conceptualization, writing, review, editing, and validation of the original draft. Cognition – FMMC, BSC, NAFF: conceptualization, writing, review, editing, and validation of the original draft; KJA: participation as reviewer. Unilateral spatial neglect – GJL: conceptualization, writing, review, editing, and validation of the original draft. Sensory impairment (hearing, vision, and touch) – ES, TPO, CM, MEPP: conceptualization, writing, review, editing, and validation of the original draft; KJA: participation as reviewer. Rehabilitation continuity: home rehabilitation, return to leisure, work, and driving – SSC, LAPSS, GJL: conceptualization, writing, review, editing, and validation of the original draft. Medication adherence – MHST, BCO, BGRBO: conceptualization, writing, review, editing and validation of the original draft. Palliative care – LON, LCGL, CGL: conceptualization, writing, review, editing, and validation of the original draft. Cerebrovascular events related to SARS-CoV-2 infection – JBCA, GSS: conceptualization, writing, review, editing, and validation of the original draft; RB: participation as reviewer. Future of stroke rehabilitation – ABC, GJL, ROC: conceptualization, writing, review, editing, and validation of the original draft. Suggested sites for patients and caregivers – LON: conceptualization, writing, review, editing, and validation of the original draft. Participation as reviwers of the entire paper: OMPN, JJFC, SCOM. CM: general coordinator; CM, RB, LON, MTP, SCSAM, ROC, GJL: coordinating group; RB: standardization and guideline coordinator; RB, CM, LON, MTP, SCSAM, ROC, GJL: standards and guidelines council; execution: Scientific Department of Neurological Rehabilitation of the Brazilian Academy of Neurology.

Conflict of Interest

The authors have no conflict of interests to declare.

References

1 Kuriakose D, Xiao Z. Pathophysiology and Treatment of Stroke: Present Status and Future Perspectives. Int J Mol Sci 2020;21(20):7609. Doi: 10.3390/ijms21207609

2 Langhorne P, Bernhardt J, Kwakkel G. Stroke rehabilitation. Lancet 2011;377(9778):1693–1702. Doi: 10.1016/S0140-6736(11)60325-5

3 Wade DT, Langton-Hewer R, Wood VA, Skilbeck CE, Ismail HM. The hemiplegic arm after stroke: measurement and recovery. J Neurol Neurosurg Psychiatry 1983;46(06):521–524. Doi: 10.1136/jnnp.46.6.521

4 Kwakkel G, Kollen B, Twisk J. Impact of time on improvement of outcome after stroke. Stroke 2006;37(09):2348–2353

5 Kwakkel G, Kollen B, Lindeman E. Understanding the pattern of functional recovery after stroke: facts and theories. Restor Neurol Neurosci 2004;22(3-5):281–299

6 Krakauer JW. Motor learning: its relevance to stroke recovery and neurorehabilitation. Curr Opin Neurol 2006;19(01):84–90. Doi: 10.1097/01.wco.0000200544.29915.cc

7 Veerbeek JM, van Wegen E, van Peppen R, et al. What is the evidence for physical therapy poststroke? A systematic review and meta-analysis. PLoS One 2014;9(02):e87987. Doi: 10.1371/journal.pone.0087987

8 Winstein CJ, Stein J, Arena R, et al;American Heart Association Stroke Council, Council on Cardiovascular and Stroke Nursing, Council on Clinical Cardiology, and Council on Quality of Care and Outcomes Research. Guidelines for Adult Stroke Rehabilitation and Recovery: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2016;47(06):e98–e169

9 Flowers HL, Skoretz SA, Silver FL, et al. Poststroke Aphasia Frequency, Recovery, and Outcomes: A Systematic Review and Meta-Analysis. Arch Phys Med Rehabil 2016;97(12):2188–2201.e8. Doi: 10.1016/j.apmr.2016.03.006

10 Brady MC, Kelly H, Godwin J, Enderby P, Campbell P. Speech and language therapy for aphasia following stroke. Cochrane Database Syst Rev 2016;2016(06):CD000425. Doi: 10.1002/14651858.CD000425.pub4

11 Godecke E, Armstrong E, Rai T, et al;VERSE Collaborative Group. A randomized control trial of intensive aphasia therapy after acute stroke: The Very Early Rehabilitation for SpEech (VERSE) study. Int J Stroke 2021;16(05):556–572. Doi: 10.1177/1747493020961926

12 Ballard KJ, Wambaugh JL, Duffy JR, et al. Treatment for Acquired Apraxia of Speech: A Systematic Review of Intervention Research Between 2004 and 2012. Am J Speech Lang Pathol 2015;24(02):316–337. Doi: 10.1044/2015_AJSLP-14-0118

13 Mitchell C, Bowen A, Tyson S, Butterfint Z, Conroy P. Interventions for dysarthria due to stroke and other adult-acquired, non-progressive brain injury. Cochrane Database Syst Rev 2017;1(01):CD002088

14 Chiaramonte R, Vecchio M. Dysarthria and stroke. The effectiveness of speech rehabilitation. A systematic review and meta-analysis of the studies. Eur J Phys Rehabil Med 2021;57(01):24–43. Doi: 10.23736/S1973-9087.20.06242-5

15 Lefaucheur JP, Aleman A, Baeken C, et al. Evidence-based guidelines on the therapeutic use of repetitive transcranial magnetic stimulation (rTMS): An update (2014-2018). Clin Neurophysiol 2020;131(02):474–528

16 Elsner B, Kugler J, Mehrholz J. Transcranial direct current stimulation (tDCS) for improving aphasia after stroke: a systematic review with network meta-analysis of randomized controlled trials. J Neuroeng Rehabil 2020;17(01):88. Doi: 10.1186/s12984-020-00708-z

17 Saxena S, Hillis AE. An update on medications and noninvasive brain stimulation to augment language rehabilitation in post-stroke aphasia. Expert Rev Neurother 2017;17(11):1091–1107

18 Kim WJ, Rosselin C, Amatya B, Hafezi P, Khan F. Repetitive transcranial magnetic stimulation for management of post-stroke impairments: An overview of systematic reviews. J Rehabil Med 2020;52(02):jrm00015. Doi: 10.2340/16501977-2637

19 Terranova C, Rizzo V, Cacciola A, et al. Is There a Future for Non-invasive Brain Stimulation as a Therapeutic Tool? Front Neurol 2019;9:1146. Doi: 10.3389/fneur.2018.01146

20 Sebastianelli L, Versace V, Martignago S, et al. Low-frequency rTMS of the unaffected hemisphere in stroke patients: A systematic review. Acta Neurol Scand 2017;136(06):585–605. Doi: 10.1111/ane.12773

21 Zhang X, Shu B, Zhang D, Huang L, Fu Q, Du G. The Efficacy and Safety of Pharmacological Treatments for Post-stroke Aphasia. CNS Neurol Disord Drug Targets 2018;17(07):509–521. Doi: 10.2174/1871527317666 180706143051

22 Zhang J, Wei R, Chen Z, Luo B. Piracetam for Aphasia in Post-stroke Patients: A Systematic Review and Meta-analysis of Randomized Controlled Trials. CNS Drugs 2016;30(07):575–587. Doi: 10.1007/s40263-016-0348-1

23 Pacheco-Castilho AC, Vanin GM, Dantas RO, Pontes-Neto OM, Martino R. Dysphagia and Associated Pneumonia in Stroke Patients from Brazil: A Systematic Review. Dysphagia 2019;34(04):499–520. Doi: 10. 1007 /s00455–019–10021–0

24 Donovan NJ, Daniels SK, Edmiaston J, Weinhardt J, Summers D, Mitchell PHAmerican Heart Association Council on Cardiovascular Nursing and Stroke Council. Dysphagia screening: state of the art: invitational conference proceeding from the State-of-the-Art Nursing Symposium, International Stroke Conference 2012. Stroke 2013;44(04):e24–e31. Doi: 10.1161/STR.0b013e3182877f57

25 Singh S, Hamdy S. Dysphagia in stroke patients. Postgrad Med J 2006;82(968):383–391. Doi: 10.1136/pgmj.2005.043281

26 Pisegna JM, Murray J. Clinical Application of Flexible Endoscopic Evaluation of Swallowing in Stroke. Semin Speech Lang 2018;39(01):3–14. Doi: 10.1055/s-0037-1608855

27 Saconato M, Leite FC, Lederman HM, Chiari BM, Gonçalves MIR. Temporal and Sequential Analysis of the Pharyngeal Phase of Swallowing in Poststroke Patients. Dysphagia 2020;35(04):598–615. Doi: 10.1007/s00455-019-10069-y

28 Bath PM, Lee HS, Everton LF. Swallowing therapy for dysphagia in acute and subacute stroke. Cochrane Database Syst Rev 2018;10(10):CD000323. Doi: 10.1002/14651858.CD000323.pub3

29 Bakhtiyari J, Sarraf P, Nakhostin-Ansari N, et al. Effects of early intervention of swallowing therapy on recovery from dysphagia following stroke. Iran J Neurol 2015;14(03):119–124

30 Chen YW, Chang KH, Chen HC, Liang WM, Wang YH, Lin YN. The effects of surface neuromuscular electrical stimulation on post-stroke dysphagia: a systemic review and meta-analysis. Clin Rehabil 2016;30(01):24–35. Doi: 10.1177/0269215515571681

31 Chiang CF, Lin MT, Hsiao MY, Yeh YC, Liang YC, Wang TG. Comparative Efficacy of Noninvasive Neurostimulation Therapies for Acute and Subacute Poststroke Dysphagia: A Systematic Review and Network Meta-analysis. Arch Phys Med Rehabil 2019;100(04):739–750.e4. Doi: 10.1016/j.apmr.2018.09.117

32 Marchina S, Pisegna JM, Massaro JM, et al. Transcranial direct current stimulation for post-stroke dysphagia: a systematic review and meta-analysis of randomized controlled trials. J Neurol 2021; 268(01):293–304. Doi: 10.1007/s00415-020-10142-9

33 Tasseel-Ponche S, Yelnik AP, Bonan IV. Motor strategies of postural control after hemispheric stroke. Neurophysiol Clin 2015;45(4-5):327–333. Doi: 10.1016/j.neucli.2015.09.003

34 Van Criekinge T, Saeys W, Vereeck L, De Hertogh W, Truijen S. Are unstable support surfaces superior to stable support surfaces during trunk rehabilitation after stroke? A systematic review. Disabil Rehabil 2018;40(17):1981–1988. Doi: 10.1080/09638288.2017.1323030

35 Van Criekinge T, Truijen S, Schröder J, et al. The effectiveness of trunk training on trunk control, sitting and standing balance and mobility post-stroke: a systematic review and meta-analysis. Clin Rehabil 2019;33(06):992–1002. Doi: 10.1177/0269215519830159

36 Zhang B, Li D, Liu Y, Wang J, Xiao Q. Virtual reality for limb motor function, balance, gait, cognition and daily function of stroke patients: A systematic review and meta-analysis. J Adv Nurs 2021;77(08):3255–3273. Doi: 10.1111/jan.14800

37 Mohammadi R, Semnani AV, Mirmohammadkhani M, Grampurohit N. Effects of Virtual Reality Compared to Conventional Therapy on Balance Poststroke: A Systematic Review and Meta-Analysis. J Stroke Cerebrovasc Dis 2019;28(07):1787–1798

38 Schröder J, van Criekinge T, Embrechts E, et al. Combining the benefits of tele-rehabilitation and virtual reality-based balance training: a systematic review on feasibility and effectiveness. Disabil Rehabil Assist Technol 2019;14(01):2–11

39 Chae CS, Jun JH, Im S, Jang Y, Park GY. Effectiveness of Hydrotherapy on Balance and Paretic Knee Strength in Patients With Stroke: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Am J Phys Med Rehabil 2020;99(05):409–419

40 Da Campo L, Hauck M, Marcolino MAZ, Pinheiro D, Plentz RDM, Cechetti F. Effects of aerobic exercise using cycle ergometry on balance and functional capacity in post-stroke patients: a systematic review and meta-analysis of randomised clinical trials. Disabil Rehabil 2021;43(11):1558–1564. Doi: 10.1080/09638288.2019.1670272

41 Tally Z, Boetefuer L, Kauk C, Perez G, Schrand L, Hoder J. The efficacy of treadmill training on balance dysfunction in individuals with chronic stroke: a systematic review. Top Stroke Rehabil 2017;24(07):539–546

42 Schröder J, Truijen S, Van Criekinge T, Saeys W. Peripheral somatosensory stimulation and postural recovery after stroke - a systematic review. Top Stroke Rehabil 2018;25(04):312–320. Doi: 10.1080/10749357.2018.1440694

43 Moucheboeuf G, Griffier R, Gasq D, et al. Effects of robotic gait training after stroke: A meta-analysis. Ann Phys Rehabil Med 2020;63(06):518–534. Doi: 10.1016/j.rehab.2020.02.008

44 Kang N, Lee RD, Lee JH, Hwang MH. Functional Balance and Postural Control Improvements in Patients With Stroke After Noninvasive Brain Stimulation: A Meta-analysis. Arch Phys Med Rehabil 2020;101(01):141–153. Doi: 10.1016/j.apmr.2019.09.003

45 Navarro-López V, Molina-Rueda F, Jiménez-Jiménez S, Alguacil-Diego IM, Carratalá-Tejada M. Effects of Transcranial Direct Current Stimulation Combined with Physiotherapy on Gait Pattern, Balance, and Functionality in Stroke Patients. A Systematic Review. Diagnostics (Basel) 2021;11(04):656. Doi: 10.3390/diagnostics11040656

46 Li RQ, Li ZM, Tan JY, Chen GL, Lin WY. Effects of motor imagery on walking function and balance in patients after stroke: A quantitative synthesis of randomized controlled trials. Complement Ther Clin Pract 2017;28:75–84. Doi: 10.1016/j.ctcp.2017.05.009

47 Hugues A, Di Marco J, Ribault S, et al. Limited evidence of physical therapy on balance after stroke: A systematic review and meta-analysis. PLoS One 2019;14(08):e0221700. Doi: 10.1371/journal.pone.0221700

48 Richards L, Senesac C, McGuirk T, et al. Response to intensive upper extremity therapy by individuals with ataxia from stroke. Top Stroke Rehabil 2008;15(03):262–271. Doi: 10.1310/tsr1503-262

49 Belas Dos Santos M, Barros de Oliveira C, Dos Santos A, Garabello Pires C, Dylewski V, Arida RM. A Comparative Study of Conventional Physiotherapy versus Robot-Assisted Gait Training Associated to Physiotherapy in Individuals with Ataxia after Stroke. Behav Neurol 2018;2018:2892065. Doi: 10.1155/2018/2892065

50 Kim WS, Jung SH, Oh MK, Min YS, Lim JY, Paik NJ. Effect of repetitive transcranial magnetic stimulation over the cerebellum on patients with ataxia after posterior circulation stroke: A pilot study. J Rehabil Med 2014;46(05):418–423. Doi: 10.2340/16501977-1802

51 Nam KE, Lim SH, Kim JS, et al. When does spasticity in the upper limb develop after a first stroke? A nationwide observational study on 861 stroke patients. J Clin Neurosci 2019;66:144–148. Doi: 10.1016/j.jocn.2019.04.034

52 Morris S. Ashworth and Tardieu Scales: Their Clinical Relevance for Measuring Spasticity in Adult and Paediatric Neurological Populations. Phys Ther Rev 2002;7(01):53–62. Doi: 10. 1179/108331902125001770

53 Hara T, Momosaki R, Niimi M, Yamada N, Hara H, Abo M. Botulinum Toxin Therapy Combined with Rehabilitation for Stroke: A Systematic Review of Effect on Motor Function. Toxins (Basel) 2019;11(12):707. Doi: 10.3390/toxins11120707

54 Lindsay C, Kouzouna A, Simcox C, Pandyan AD. Pharmacological interventions other than botulinum toxin for spasticity after stroke. Cochrane Database Syst Rev 2016;10(10):CD010362. Doi: 10.1002/14651858

55 Andringa A, van de Port I, van Wegen E, Ket J, Meskers C, Kwakkel G. Effectiveness of Botulinum Toxin Treatment for Upper Limb Spasticity Poststroke Over Different ICF Domains: A Systematic Review and Meta-Analysis. Arch Phys Med Rehabil 2019;100(09):1703–1725. Doi: 10.1016/j.apmr.2019.01.016

56 Santamato A, Cinone N, Panza F, et al. Botulinum Toxin Type A for the Treatment of Lower Limb Spasticity after Stroke. Drugs 2019; 79(02):143–160. Doi: 10.1007/s40265-018-1042-z

57 Gupta AD, Chu WH, Howell S, et al. A systematic review: efficacy of botulinum toxin in walking and quality of life in post-stroke lower limb spasticity. Syst Rev 2018;7(01):1. Doi: 10.1186/s13643-017-0670-9

58 Francisco GE, Balbert A, Bavikatte G, et al. A practical guide to optimizing the benefits of post-stroke spasticity interventions with botulinum toxin A: An international group consensus. J Rehabil Med 2021;53(01):jrm00134. Doi: 10.2340/16501977-2753

59 Creamer M, Cloud G, Kossmehl P, et al. Effect of Intrathecal Baclofen on Pain and Quality of Life in Poststroke Spasticity. Stroke 2018;49(09):2129–2137

60 Bai YL, Hu YS, Wu Y, et al. Long-term three-stage rehabilitation intervention alleviates spasticity of the elbows, fingers, and plantar flexors and improves activities of daily living in ischemic stroke patients: a randomized, controlled trial. Neuroreport 2014;25(13):998–1005. Doi: 10.1097/WNR.0000000000000194

61 Huang YC, Chen PC, Tso HH, Yang YC, Ho TL, Leong CP. Effects of kinesio taping on hemiplegic hand in patients with upper limb post-stroke spasticity: a randomized controlled pilot study. Eur J Phys Rehabil Med 2019;55(05):551–557. Doi: 10.23736/S1973-9087.19.05684-3

62 Basaran A, Emre U, Karadavut KI, Balbaloglu O, Bulmus N. Hand splinting for poststroke spasticity: a randomized controlled trial. Top Stroke Rehabil 2012;19(04):329–337. Doi: 10.1310/tsr1904-329

63 Mahmood A, Veluswamy SK, Hombali A, Mullick A, N. M, Solomon JM. Effect of Transcutaneous Electrical Nerve Stimulation on Spasticity in Adults With Stroke: A Systematic Review and Meta-analysis. Arch Phys Med Rehabil 2019;100(04):751–768. Doi: 10.1016/j.apmr.2018.10.016

64 You G, Liang H, Yan T. Functional electrical stimulation early after stroke improves lower limb motor function and ability in activities of daily living. NeuroRehabilitation 2014;35(03): 381–389. Doi: 10.3233/NRE-141129

65 Zhu Y, Yang Y, Li J. Does acupuncture help patients with spasticity? A narrative review. Ann Phys Rehabil Med 2019;62 (04):297–301. Doi: 10.1016/j.rehab.2018.09.010

66 Hatem SM, Saussez G, Della Faille M, et al. Rehabilitation of Motor Function after Stroke: A Multiple Systematic Review Focused on Techniques to Stimulate Upper Extremity Recovery. Front Hum Neurosci 2016;10:442https://doi.org/. Doi: 10.3389/fnhum.2016.00442

67 Díaz-Arribas MJ, Martín-Casas P, Cano-de-la-Cuerda R, Plaza-Manzano G. Effectiveness of the Bobath concept in the treatment of stroke: a systematic review. Disabil Rehabil 2020;42(12): 1636–1649

68 Harris JE, Eng JJ. Strength training improves upper-limb function in individuals with stroke: a meta-analysis. Stroke 2010;41(01): 136–140. Doi: 10.1161/ STROKEAHA.109.567438

69 Veldema J, Jansen P. Resistance training in stroke rehabilitation: systematic review and meta-analysis. Clin Rehabil 2020;34(09): 1173–1197. Doi: 10.1177/0269215520932964

70 Corbetta D, Sirtori V, Castellini G, Moja L, Gatti R. Constraint-induced movement therapy for upper extremities in people with stroke. Cochrane Database Syst Rev 2015; ((10):CD004433

71 Liu XH, Huai J, Gao J, Zhang Y, Yue SW. Constraint-induced movement therapy in treatment of acute and sub-acute stroke: a meta-analysis of 16 randomized controlled trials. Neural Regen Res 2017;12(09):1443–1450. Doi: 10.4103/1673-5374.215255

72 Molier BI, Van Asseldonk EH, Hermens HJ, Jannink MJ. Nature, timing, frequency and type of augmented feedback; does it influence motor relearning of the hemiparetic arm after stroke? A systematic review. Disabil Rehabil 2010;32(22):1799–1809. Doi: 10.3109/ 09638281 003734359

73 Thieme H, Morkisch N, Mehrholz J, et al. Mirror therapy for improving motor function after stroke. Cochrane Database Syst Rev 2018;7(07):CD008449

74 Luo Z, Zhou Y, He H, et al. Synergistic Effect of Combined Mirror Therapy on Upper Extremity in Patients With Stroke: A Systematic Review and Meta-Analysis. Front Neurol 2020;11:155. Doi: 10.3389/fneur.2020.00155

75 Stockley RC, Jarvis K, Boland P, Clegg AJ. Systematic Review and Meta-Analysis of the Effectiveness of Mental Practice for the Upper Limb After Stroke: Imagined or Real Benefit? Arch Phys Med Rehabil 2021;102(05):1011–1027. Doi: 10.1016/j. apmr.2020.09.391

76 Chen PM, Kwong PWH, Lai CKY, Ng SSM. Comparison of bilateral and unilateral upper limb training in people with stroke: A systematic review and meta-analysis. PLoS One 2019;14(05): e0216357

77 Conforto AB, Dos Anjos SM, Bernardo WM, et al. Repetitive Peripheral Sensory Stimulation and Upper Limb Performance in Stroke: A Systematic Review and Meta-analysis. Neurorehabil Neural Repair 2018;32(10):863–871. Doi: 10.1177/ 1545968318798943

78 Bai X, Guo Z, He L, Ren L, McClure MA, Mu Q. Different Therapeutic Effects of Transcranial Direct Current Stimulation on Upper and Lower Limb Recovery of Stroke Patients with Motor Dysfunction: A Meta-Analysis. Neural Plast 2019; 2019:1372138. Doi: 10.1155/2019/ 1372138

79 van Lieshout ECC, van der Worp HB, Visser-Meily JMA, Dijkhuizen RM. Timing of Repetitive Transcranial Magnetic Stimulation Onset for Upper Limb Function After Stroke: A Systematic Review and Meta-Analysis. Front Neurol 2019;10:1269. Doi: 10.3389/fneur.2019.01269

80 Eraifej J, Clark W, France B, Desando S, Moore D. Effectiveness of upper limb functional electrical stimulation after stroke for the improvement of activities of daily living and motor function: a systematic review and meta-analysis. Syst Rev 2017;6(01):40. Doi: 10.1186/s13643-017-0435-5

81 Lee SH, Jung H-Y, Yun SJ, Oh B-M, Seo HG. Upper extremity rehabilitation using fully immersive virtual reality games with a head mount display: a feasibility study. PM R 2020;12(03): 257–262. Doi: 10.1002/pmrj.12206

82 Karamians R, Proffitt R, Kline D, Gauthier LV. Effectiveness of Virtual Reality- and Gaming-Based Interventions for Upper Extremity Rehabilitation Poststroke: A Meta-analysis. Arch Phys Med Rehabil 2020;101(05):885–896. Doi: 10.1016/j. apmr.2019.10.195

83 Dehem S, Montedoro V, Edwards MG, et al. Development of a robotic upper limb assessment to configure a serious game. NeuroRehabilitation 2019;44(02):263–274

84 Hocine N, Gouaïch A, Cerri SA, et al. Adaptation in serious games for upper-limb rehabilitation: an approach to improve training outcomes. User Model User-adapt Interact 2015;25(01):65–98

85 Laver KE, Lange B, George S, Deutsch JE, Saposnik G, Crotty M. Virtual reality for stroke rehabilitation. Cochrane Database Syst Rev 2017;11(11):CD008349. Doi: 10.1002/14651858.CD008349. pub4

86 Doumas I, Everard G, Dehem S, Lejeune T. Serious games for upper limb rehabilitation after stroke: a meta-analysis. J Neuroeng Rehabil 2021;18(01):100. Doi: 10.1186/s12984-021-00889-1

87 Wu J, Cheng H, Zhang J, Yang S, Cai S. Robot-Assisted Therapy for Upper Extremity Motor Impairment After Stroke: A Systematic Review and Meta-Analysis. Phys Ther 2021 Apr 4;101(04): pzab010. Doi: 10.1093/ptj/pzab010

88 EFFECTS Trial Collaboration. Safety and efficacy of fluoxetine on functional recovery after acute stroke (EFFECTS): a randomised, double-blind, placebo-controlled trial. Lancet Neurol 2020;19 (08):661–669. Doi: 10.1016/ S1474–4422(20)30219–2

89 FOCUS Trial Collaboration. Effects of fluoxetine on functional outcomes after acute stroke (FOCUS): a pragmatic, double-blind, randomised, controlled trial. Lancet 2019;393(10168):265–274. Doi: 10.1016/S0140-6736(18)32823-X

90 Beghi E, Binder H, Birle C, et al. European Academy of Neurology and European Federation of Neurorehabilitation Societies guideline on pharmacological support in early motor rehabilitation after acute ischaemic stroke. Eur J Neurol 2021;28(09):2831-–2845. Doi: 10.1111/ene.14936

91 Veerbeek JM, Van Wegen EE, Harmeling-Van der Wel BC, Kwakkel GEPOS Investigators. Is accurate prediction of gait in nonambulatory stroke patients possible within 72 hours poststroke? The EPOS study. Neurorehabil Neural Repair 2011;25(03):268–274. Doi: 10.1177/ 1545968310384271

92 Saunders DH, Sanderson M, Hayes S, et al. Physical fitness training for stroke patients. Cochrane Database Syst Rev 2020; 3(03):CD003316. Doi: 10.1002/14651858.CD003316.pub7

93 English C, Hillier SL, Lynch EA. Circuit class therapy for improving mobility after stroke. Cochrane Database Syst Rev 2017;6(06): CD007513. Doi: 10.1002/14651858.CD007513.pub3

94 Ghai S, Ghai I. Effects of (music-based) rhythmic auditory cueing training on gait and posture post-stroke: A systematic review & dose-response meta-analysis. Sci Rep 2019;9(01):2183. Doi: 10.1038/ s41598–019–38723–3

95 Nascimento LR, Flores LC, de Menezes KKP, Teixeira-Salmela LF. Water-based exercises for improving walking speed, balance, and strength after stroke: a systematic review with meta-analyses of

randomized trials. Physiotherapy 2020;107:100–110. Doi: 10.1016/j.physio.2019.10.002
96 Mehrholz J, Thomas S, Elsner B. Treadmill training and body weight support for walking after stroke. Cochrane Database Syst Rev 2017;8(08):CD002840. Doi: 10.1002/14651858.CD002840.pub4
97 Nascimento LR, Boening A, Galli A, Polese JC, Ada L. Treadmill walking improves walking speed and distance in ambulatory people after stroke and is not inferior to overground walking: a systematic review. J Physiother 2021;67(02):95–104
98 Mehrholz J, Thomas S, Kugler J, Pohl M, Elsner B. Electromechanical-assisted training for walking after stroke. Cochrane Database Syst Rev 2020;10(10):CD006185. Doi: 10.1002/14651858.CD006185.pub5
99 Mehrholz J, Thomas S, Werner C, Kugler J, Pohl M, Elsner B. Electromechanical-Assisted Training for Walking After Stroke: A Major Update of the Evidence. Stroke 2017;52(05):e153–e154. Doi: 10.1161/STROKEAHA.120.033755
100 Schröder J, Truijen S, Van Criekinge T, Saeys W. Feasibility and effectiveness of repetitive gait training early after stroke: A systematic review and meta-analysis. J Rehabil Med 2019;51(02):78–88. Doi: 10.2340/16501977-2505
101 Silva S, Borges LR, Santiago L, Lucena L, Lindquist AR, Ribeiro T. Motor imagery for gait rehabilitation after stroke. Cochrane Database Syst Rev 2020;9(09):CD013019
102 Yang A, Wu HM, Tang JL, Xu L, Yang M, Liu GJ. Acupuncture for stroke rehabilitation. Cochrane Database Syst Rev 2016;2016(08):CD004131. Doi: 10.1002/14651858.CD004131.pub3
103 Tyson SF, Sadeghi-Demneh E, Nester CJ. A systematic review and meta-analysis of the effect of an ankle-foot orthosis on gait biomechanics after stroke. Clin Rehabil 2013;27(10):879–891. Doi: 10.1177/026921 5513486497
104 de Paula GV, da Silva TR, de Souza JT, et al. Effect of ankle-foot orthosis on functional mobility and dynamic balance of patients after stroke: Study protocol for a randomized controlled clinical trial. Medicine (Baltimore) 2019;98(39):e17317
105 Shahabi S, Shabaninejad H, Kamali M, Jalali M, Ahmadi Teymourlouy A. The effects of ankle-foot orthoses on walking speed in patients with stroke: a systematic review and meta-analysis of randomized controlled trials. Clin Rehabil 2020;34(02):145–159. Doi: 10.1177/ 026921551 9887784
106 Daryabor A, Yamamoto S, Orendurff M, Kobayashi T. Effect of types of ankle-foot orthoses on energy expenditure metrics during walking in individuals with stroke: a systematic review. Disabil Rehabil 2022;44(02):166–176. Doi: 10.1080/09638288.2020.1762767
107 Johnston TE, Keller S, Denzer-Weiler C, Brown L. A Clinical Practice Guideline for the Use of Ankle-Foot Orthoses and Functional Electrical Stimulation Post-Stroke. J Neurol Phys Ther 2021;45(02):112–196
108 Nascimento LR, da Silva LA, Araújo Barcellos JVM, Teixeira-Salmela LF. Ankle-foot orthoses and continuous functional electrical stimulation improve walking speed after stroke: a systematic review and meta-analyses of randomized controlled trials. Physiotherapy 2020;109:43–53. Doi: 10.1016/j.physio.2020.08.002
109 Jaqueline da Cunha M, Rech KD, Salazar AP, Pagnussat AS. Functional electrical stimulation of the peroneal nerve improves post-stroke gait speed when combined with physiotherapy. A systematic review and meta-analysis. Ann Phys Rehabil Med 2021;64(01):101388. Doi: 10.1016/j.rehab.2020.03.012
110 Beauchamp MK, Skrela M, Southmayd D, et al. Immediate effects of cane use on gait symmetry in individuals with subacute stroke. Physiother Can 2009;61(03):154–160. Doi: 10.3138/physio.61.3.154
111 Avelino PR, Nascimento LR, Menezes KKP, Scianni AA, Ada L, Teixeira-Salmela LF. Effect of the provision of a cane on walking and social participation in individuals with stroke: protocol for a randomized trial. Braz J Phys Ther 2018;22(02):168–173. Doi: 10.1016/j.bjpt.2017.11.002
112 Jeong YG, Jeong YJ, Myong JP, Koo JW. Which type of cane is the most efficient, based on oxygen consumption and balance capacity, in chronic stroke patients? Gait Posture 2015;41(02):493–498
113 Caro CC, Costa JD, Cruz DMC. The use of mobility assistive devices and the functional independence in stroke patients. Cad Bras Ter Ocup. 2018;26(03):558–568. Doi: 10.4322/2526-8910.ctoao1117
114 Madureira S, Guerreiro M, Ferro JM. Dementia and cognitive impairment three months after stroke. Eur J Neurol 2001;8(06):621–627. Doi: 10.1046/j.1468-1331.2001.00332.x
115 Skrobot OA, O'Brien J, Black S, et al;VICCCS group. The Vascular Impairment of Cognition Classification Consensus Study. Alzheimers Dement 2017;13(06):624–633
116 Hachinski V, Iadecola C, Petersen RC, Breteler MM, Nyenhuis DL, Black SE, Powers WJ, DeCarli C, Merino JG, Kalaria RN, Vinters HV, Holtzman DM, Rosenberg GA, Wallin A, Dichgans M, Marler JR, Leblanc GG. National Institute of Neurological Disorders and Stroke-Canadian Stroke Network vascular cognitive impairment harmonization standards. Stroke 2006 sep;37(09):2220–41. Doi: 10.1161/01.STR.0000237236.88823.47. Erratum in: Stroke. 2007 Mar;38(3):1118
117 Lees R, Selvarajah J, Fenton C, et al. Test accuracy of cognitive screening tests for diagnosis of dementia and multidomain cognitive impairment in stroke. Stroke 2014;45(10):3008-–3018. Doi: 10.1161/STROKEAHA.114.005842
118 Celis H, Fagard RH, Staessen JA, Thijs LSystolic Hypertension in Europe Trial Investigators. Risk and benefit of treatment of isolated systolic hypertension in the elderly: evidence from the Systolic Hypertension in Europe Trial. Curr Opin Cardiol 2001;16(06):342–348. Doi: 10.1097/00001573-200111000-00005
119 Yang Z, Wang H, Edwards D, et al. Association of blood lipids, atherosclerosis and statin use with dementia and cognitive impairment after stroke: A systematic review and meta-analysis. Ageing Res Rev 2020;57:100962
120 Gorelick PB, Scuteri A, Black SE, et al;American Heart Association Stroke Council, Council on Epidemiology and Prevention, Council on Cardiovascular Nursing, Council on Cardiovascular Radiology and Intervention, and Council on Cardiovascular Surgery and Anesthesia. Vascular contributions to cognitive impairment and dementia: a statement for healthcare professionals from the american heart association/american stroke association. Stroke 2011;42(09):2672–2713
121 Shu Y, He Q, Xie Y, Zhang W, Zhai S, Wu T. Cognitive Gains of Aerobic Exercise in Patients With Ischemic Cerebrovascular Disorder: A Systematic Review and Meta-Analysis. Front Cell Dev Biol 2020;8:582380. Doi: 10.3389/fcell.2020.582380
122 das Nair R, Cogger H, Worthington E, Lincoln NB. Cognitive rehabilitation for memory deficits after stroke. Cochrane Database Syst Rev 2016;9(09):CD002293. Doi: 10.1002/14651858.CD002293.pub3
123 Cappa SF, Benke T, Clarke S, Rossi B, Stemmer B, van Heugten CMTask Force on Cognitive Rehabilitation European Federation of Neurological Societies. EFNS guidelines on cognitive rehabilitation: report of an EFNS task force. Eur J Neurol 2005;12(09):665–680. Doi: 10.1111/j.1468-1331.2005.01330.x
124 Bo W, Lei M, Tao S, et al. Effects of combined intervention of physical exercise and cognitive training on cognitive function in stroke survivors with vascular cognitive impairment: a randomized controlled trial. Clin Rehabil 2019;33(01):54–63. Doi: 10.1177/0269215518791007
125 Faria AL, Pinho MS, Bermúdez I Badia S. A comparison of two personalization and adaptive cognitive rehabilitation approaches: a randomized controlled trial with chronic stroke patients. J Neuroeng Rehabil 2020;17(01):78. Doi: 10.1186/s12984-020-00691-5

126 Hung CY, Wu XY, Chung VC, Tang EC, Wu JC, Lau AY. Overview of systematic reviews with meta-analyses on acupuncture in post-stroke cognitive impairment and depression management. Integr Med Res 2019;8(03):145–159. Doi: 10.1016/j.imr.2019.05.001

127 Hara T, Shanmugalingam A, McIntyre A, Burhan AM. The Effect of Non-Invasive Brain Stimulation (NIBS) on Attention and Memory Function in Stroke Rehabilitation Patients: A Systematic Review and Meta-Analysis. Diagnostics (Basel) 2021;11(02):227. Doi: 10.3390/diagnostics11020227

128 Renton T, Tibbles A, Topolovec-Vranic J. Neurofeedback as a form of cognitive rehabilitation therapy following stroke: A systematic review. PLoS One 2017;12(05):e0177290. Doi: 10.1371/journal.pone.0177290

129 Cubelli R. Definition: Spatial neglect. Cortex 2017;92:320–321. Doi: 10.1016/j.cortex.2017.03.021

130 Parton A, Malhotra P, Husain M. Hemispatial neglect. J Neurol Neurosurg Psychiatry 2004;75(01):13–21

131 Luvizutto GJ, Moliga AF, Rizzatti GRS, et al. Unilateral spatial neglect in the acute phase of ischemic stroke can predict long-term disability and functional capacity. Clinics (São Paulo) 2018; 73:e131. Doi: 10.6061/clinics/2018/e131

132 Dintén-Fernández A, Fernández-González P, Koutsou A, Alguacil-Diego IM, Laguarta-Val S, Molina-Rueda F. [Top-down and bottom-up approaches for the treatment of unilateral spatial neglect in stroke patients: A systematic review]. Rehabilitacion (Madr) 2019;53(02):93–103 Spanish. Doi: 10.1016/j.rh.2018.10.001

133 Ogourtsova T, Souza Silva W, Archambault PS, Lamontagne A. Virtual reality treatment and assessments for post-stroke unilateral spatial neglect: A systematic literature review. Neuropsychol Rehabil 2017;27(03):409–454. Doi: 10.1080/09602011.2015.1113187

134 Kashiwagi FT, El Dib R, Gomaa H, et al. Noninvasive Brain Stimulations for Unilateral Spatial Neglect after Stroke: A Systematic Review and Meta-Analysis of Randomized and Nonrandomized Controlled Trials. Neural Plast 2018;2018:1638763. Doi: 10.1155/2018/1638763

135 Cotoi A, Mirkowski M, Iruthayarajah J, Anderson R, Teasell R. The effect of theta-burst stimulation on unilateral spatial neglect following stroke: a systematic review. Clin Rehabil 2019;33(02):183–194. Doi: 10.1177/0269215518804018

136 Elsner B, Kugler J, Pohl M, Mehrholz J. Transcranial direct current stimulation (tDCS) for improving activities of daily living, and physical and cognitive functioning, in people after stroke. Cochrane Database Syst Rev 2020;11(11):CD009645. Doi: 10.1002/14651858.CD009645.pub4

137 Tyson SF, Hanley M, Chillala J, Selley AB, Tallis RC. Sensory loss in hospital-admitted people with stroke: characteristics, associated factors, and relationship with function. Neurorehabil Neural Repair 2008;22(02):166–172. Doi: 10.1177/1545968307305523

138 Parker J, Mountain G, Hammerton J. A review of the evidence underpinning the use of visual and auditory feedback for computer technology in post-stroke upper-limb rehabilitation. Disabil Rehabil Assist Technol 2011;6(06):465–472

139 Kim HA, Yi HA, Lee H. Recent Advances in Cerebellar Ischemic Stroke Syndromes Causing Vertigo and Hearing Loss. Cerebellum 2016;15(06):781–788. Doi: 10.1007/s12311-015-0745-x

140 Kuo CL, Shiao AS, Wang SJ, Chang WP, Lin YY. Risk of sudden sensorineural hearing loss in stroke patients: A 5-year nationwide investigation of 44,460 patients. Medicine (Baltimore) 2016;95(36):e4841. Doi: 10.1097/MD.0000000000004841

141 Landi F, Onder G, Cesari M, et al;Silvernet-HC study group. Functional decline in frail community-dwelling stroke patients. Eur J Neurol 2006;13(01):17–23

142 Koohi N, Vickers D, Chandrashekar H, Tsang B, Werring D, Bamiou DE. Auditory rehabilitation after stroke: treatment of auditory processing disorders in stroke patients with personal frequency-modulated (FM) systems. Disabil Rehabil 2017;39(06):586–593

143 Koohi N, Vickers D, Warren J, Werring D, Bamiou DE. Long-term use benefits of personal frequency-modulated systems for speech in noise perception in patients with stroke with auditory processing deficits: a non-randomised controlled trial study. BMJ Open 2017;7(04):e013003. Doi: 10.1136/bmjopen-2016-013003

144 Rowe FJ, Hepworth LR, Howard C, Hanna KL, Cheyne CP, Currie J. High incidence and prevalence of visual problems after acute stroke: An epidemiology study with implications for service delivery. PLoS One 2019;14(03):e0213035. Doi: 10.1371/journal.pone.0213035

145 Rowe FJVIS writing Group. Vision In Stroke cohort: Profile overview of visual impairment. Brain Behav 2017;7(11):e00771. Doi: 10.1002/brb3.771

146 Pollock A, Hazelton C, Rowe FJ, et al. Interventions for visual field defects in people with stroke. Cochrane Database Syst Rev 2019; 5(05):CD008388. Doi: 10.1002/14651858.CD008388.pub3

147 Carey LM, Matyas TA, Baum C. Effects of Somatosensory Impairment on Participation After Stroke. Am J Occup Ther 2018;72(03):p1, p10

148 Kessner SS, Schlemm E, Cheng B, et al. Somatosensory Deficits After Ischemic Stroke. Stroke 2019;50(05):1116–1123. Doi: 10.1161/STROKEAHA.118.023750

149 de Diego C, Puig S, Navarro X. A sensorimotor stimulation program for rehabilitation of chronic stroke patients. Restor Neurol Neurosci 2013;31(04):361–371. Doi: 10.3233/RNN-120250

150 Chia FS, Kuys S, Low Choy N. Sensory retraining of the leg after stroke: systematic review and meta-analysis. Clin Rehabil 2019; 33(06):964–979. Doi: 10.1177/0269215519836461

151 Turville ML, Cahill LS, Matyas TA, Blennerhassett JM, Carey LM. The effectiveness of somatosensory retraining for improving sensory function in the arm following stroke: a systematic review. Clin Rehabil 2019;33(05):834–846. Doi: 10.1177/0269215519829795

152 Chi NF, Huang YC, Chiu HY, Chang HJ, Huang HC. Systematic Review and Meta-Analysis of Home-Based Rehabilitation on Improving Physical Function Among Home-Dwelling Patients With a Stroke. Arch Phys Med Rehabil 2020;101(02):359–373

153 Graef P, Michaelsen SM, Dadalt ML, Rodrigues DA, Pereira F, Pagnussat AS. Effects of functional and analytical strength training on upper-extremity activity after stroke: a randomized controlled trial. Braz J Phys Ther 2016;20(06):543–552. Doi: 10.1590/bjpt-rbf.2014.0187

154 Hsieh YW, Chang KC, Hung JW, Wu CY, Fu MH, Chen CC. Effects of Home-Based Versus Clinic-Based Rehabilitation Combining Mirror Therapy and Task-Specific Training for Patients With Stroke: A Randomized Crossover Trial. Arch Phys Med Rehabil 2018;99(12):2399–2407. Doi: 10.1016/j.apmr.2018.03.017

155 Rossit S, Benwell CSY, Szymanek L, et al. Efficacy of home-based visuomotor feedback training in stroke patients with chronic hemispatial neglect. Neuropsychol Rehabil 2019;29(02):251–272. Doi: 10.1080/ 09602011.2016.1273119

156 Thielbar KO, Triandafilou KM, Barry AJ, et al. Home-based Upper Extremity Stroke Therapy Using a Multiuser Virtual Reality Environment: A Randomized Trial. Arch Phys Med Rehabil 2020;101(02):196–203. Doi: 10.1016/j.apmr.2019.10.182

157 Zondervan DK, Friedman N, Chang E, et al. Home-based hand rehabilitation after chronic stroke: Randomized, controlled single-blind trial comparing the MusicGlove with a conventional exercise program. J Rehabil Res Dev 2016;53(04):457–472. Doi: 10.1682/JRRD.2015.04.0057

158 Huang HC, Huang YC, Lin MF, et al. Effects of Home-Based Supportive Care on Improvements in Physical Function and Depressive Symptoms in Patients With Stroke: A Meta-Analysis.

Arch Phys Med Rehabil 2017;98(08):1666–1677.e1. Doi: 10.1016/j.apmr.2017.03.014

159 Nascimento LR, Scianni AA, Ada L, Fantauzzi MO, Hirochi TL, Teixeira-Salmela LF. Predictors of return to work after stroke: a prospective, observational cohort study with 6 months follow-up. Disabil Rehabil 2021;43(04):525–529. Doi: 10.1080/09638288.2019.1631396

160 Ntsiea MV, Van Aswegen H, Lord S, Olorunju S S. The effect of a workplace intervention programme on return to work after stroke: a randomised controlled trial. Clin Rehabil 2015;29 (07):663–673. Doi: 10.1177/0269215514554241

161 Johansson U, Hellman T, Öst Nilsson A, Eriksson G. The ReWork-Stroke rehabilitation programme described by use of the TIDieR checklist. Scand J Occup Ther 2021;28(05):375–383. Doi: 10.1080/11038128.2020.1790654

162 George S, Crotty M, Gelinas I, Devos H. Rehabilitation for improving automobile driving after stroke. Cochrane Database Syst Rev 2014;2014(02):CD008357. Doi: 10.1002/14651858.CD008357.pub2

163 Jung NH, Kim H, Chang M. Muscle activation of drivers with hemiplegia caused by stroke while driving using a steering wheel or knob. J Phys Ther Sci 2015;27(04):1009–1011. Doi: 10.1589/jpts.27.1009

164 Sabaté E Adherence to Long-Term Therapies: Evidence for Action. World Health Organization (WHO). Geneva, Switzerland: World Health Organization (WHO); 2003:1–209 p.

165 Ozaki AF, Choi AS, Le QT, et al. Real-World Adherence and Persistence to Direct Oral Anticoagulants in Patients With Atrial Fibrillation: A Systematic Review and Meta-Analysis. Circ Cardiovasc Qual Outcomes 2020;13(03):e005969. Doi: 10.1161/CIRCOUTCOMES.119.005969

166 Xu T, Yu X, Ou S, et al. Adherence to Antihypertensive Medications and Stroke Risk: A Dose-Response Meta-Analysis. J Am Heart Assoc 2017;6(07):e006371. Doi: 10.1161/ JAHA.117.006371

167 Aarnio K, Haapaniemi E, Melkas S, Kaste M, Tatlisumak T, Putaala J. Long-term mortality after first-ever and recurrent stroke in young adults. Stroke 2014;45(09):2670–2676. Doi: 10.1161/STROKEAHA.114.005648

168 Adler AJ, Martin N, Mariani J, et al. Mobile phone text messaging to improve medication adherence in secondary prevention of cardiovascular disease. Cochrane Database Syst Rev 2017;4(04): CD011851. Doi: 10.1002/14651858.CD011851.pub2

169 Kraft P, Hillmann S, Rücker V, Heuschmann PU. Telemedical strategies for the improvement of secondary prevention in patients with cerebrovascular events-A systematic review and meta-analysis. Int J Stroke 2017;12(06):597–605. Doi: 10.1177/1747493017706188

170 Wessol JL, Russell CL, Cheng AL. A Systematic Review of Randomized Controlled Trials of Medication Adherence Interventions in Adult Stroke Survivors. J Neurosci Nurs 2017;49(02): 120–133. Doi: 10.1097/ JNN.0000000000000266

171 World Health Organization definition of palliative care. Accessed on September 18, 2020. https://www.who.int/cancer/palliative/definition/en/

172 Holloway RG, Arnold RM, Creutzfeldt CJ, et al;American Heart Association Stroke Council, Council on Cardiovascular and Stroke Nursing, and Council on Clinical Cardiology. Palliative and end-of-life care in stroke: a statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2014;45(06):1887–1916

173 Creutzfeldt CJ, Kluger B, Kelly AG, et al. Neuropalliative care: Priorities to move the field forward. Neurology 2018;91(05): 217–226. Doi: 10.1212/WNL.000000000000 59 16

174 Harapan BN, Yoo HJ. Neurological symptoms, manifestations, and complications associated with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease 19 (COVID-19). J Neurol 2021;268(09):3059–3071. Doi: 10.1007/s00415-021-10406-y

175 Smith EE, Mountain A, Hill MD, et al;Canadian Stroke Best Practices Advisory Council. Canadian Stroke Best Practice Guidance During the COVID-19 Pandemic. Can J Neurol Sci 2020;47 (04):474–478. Doi: 10.1017/cjn.2020.74

176 Murphy TH, Corbett D. Plasticity during stroke recovery: from synapse to behaviour. Nat Rev Neurosci 2009;10(12):861–872. Doi: 10.1038/nrn2735

177 Cramer SC. Recovery After Stroke. Continuum (Minneap Minn) 2020;26(02):415–434. Doi: 10.1212/CON.0000000000000838

178 Knepley KD, Mao JZ, Wieczorek P, Okoye FO, Jain AP, Harel NY. Impact of Telerehabilitation for Stroke-Related Deficits. Telemed J E Health 2021;27(03):239–246. Doi: 10.1089/tmj.2020.0019

179 Cramer SC, Dodakian L, Le V, et al;National Institutes of Health StrokeNet Telerehab Investigators. Efficacy of Home-Based Telerehabilitation vs In-Clinic Therapy for Adults After Stroke: A Randomized Clinical Trial. JAMA Neurol 2019;76(09):1079––1087. Doi: 10.1001/jamaneurol.2019.1604

180 Ang KK, Guan C, Chua KS, et al. A clinical evaluation on the spatial patterns of non-invasive motor imagery-based brain-computer interface in stroke. Annu Int Conf IEEE Eng Med Biol Soc 2008; 2008:4174–4177. Doi: 10.1109/IEMBS.2008.4650129

181 Capela NA, Lemaire ED, Baddour N, Rudolf M, Goljar N, Burger H. Evaluation of a smartphone human activity recognition application with able-bodied and stroke participants. J Neuroeng Rehabil 2016;13:5. Doi: 10.1186/s12984-016-0114-0

182 Grawemeyer B, Cox R, Lum C. AUDIX: a knowledge-based system for speech-therapeutic auditory discrimination exercises. Stud Health Technol Inform 2000;77:568–572

183 Colomer C, Llorens R, Noé E, Alcañiz M. Effect of a mixed reality-based intervention on arm, hand, and finger function on chronic stroke. J Neuroeng Rehabil 2016;13(01):45. Doi: 10.1186/s12984-016-0153-6 Erratum in: J Neuroeng Rehabil. 2017;14 (1):12

184 Sung HC, Chang SM, Chin MY, Lee WL. Robot-assisted therapy for improving social interactions and activity participation among institutionalized older adults: a pilot study. Asia-Pac Psychiatry 2015;7(01):1–6. Doi: 10.1111/appy.12131

185 Cacho RO, Conforto AB, Guarda SNF, Pinto EB, Moro CHC, Bazan R, et al. Access to rehabilitation after stroke in Brazil (AReA Study). An Observational multicenter protocol. Arq Neuropsiquiatr 2021 sep 79, Suppl 1.

