Stroke

AHA/ASA GUIDELINE

2026 Guideline for Adult Stroke Rehabilitation and Recovery: A Guideline From the American Heart Association and American Stroke Association

Endorsed by the American Academy of Physical Medicine and Rehabilitation, American Congress of Rehabilitation Medicine, American Society of Neurorehabilitation, American Physical Therapy Association, and the American Therapeutic Recreation Association.

The American Academy of Neurology affirms the value of this statement as an educational tool for neurologists.

The American Occupational Therapy Association recognizes the value of this guideline and its potential to inform clinical practice.

The American Speech-Language Hearing Association recognizes the values and role of interdisciplinary guidelines such as this document in the management of communication, cognitive, and swallowing disorders.

The Association of Rehabilitation Nurses endorses the guideline as an evidence-based resource to support interdisciplinary care across the rehabilitation continuum.[1]

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[1]ARN recognizes the guideline's value in promoting high-quality, patient-centered rehabilitation and advancing clinical practice for individuals recovering from stroke.

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AIM: The "2026 Guidelines for Adult Stroke Rehabilitation and Recovery" replaces the 2016 "Guidelines for Adult Stroke Rehabilitation and Recovery." This updated guideline is intended to provide a comprehensive, up-to-date, evidence-based set of recommendations. The intended audience includes physicians, allied health professionals, and caregivers.

METHODS: A comprehensive search for literature published since the 2016 guideline, derived from research involving human participants, published in English, and indexed in MEDLINE, PubMed, Cochrane Library, and other selected databases relevant to this guideline, was conducted between June and October 2025. Other documents on related subject matter previously published by the American Heart Association were also reviewed.

STRUCTURE: This guideline provides recommendations based on the most current evidence available for stroke rehabilitation and recovery. Key updates include new and revised recommendations across the stroke recovery continuum, including the assessment and treatment of medical comorbidities, fracture risk, fall prevention, technology-enabled rehabilitation, caregiver support, participation, and safe return to work and driving. Although this guideline reflects significant advances, it also highlights gaps in knowledge and underscores the urgent need for continued research to further refine and improve treatment strategies.

Key Words: AHA Scientific Statements ■ caregiver ■ guideline ■ recovery ■ rehabilitation ■ stroke

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TOP TAKE-HOME MESSAGES

1. Participation in multidisciplinary rehabilitation therapies is critical to reduce neurological impairment and improve function after stroke. Because of the varied nature of body structure and function impairments that can occur, improving function requires a combination of restorative and compensatory interventions.
2. Longitudinal coordinated communication among rehabilitation and other providers is essential to avoid gaps in care and to deliver efficient, effective, and high-value rehabilitation across the continuum. Rehabilitation should begin in the acute phase of stroke care.
3. Rehabilitation combines interventions aimed at the restitution of body structure and function and learning compensatory strategies. Uncertainty remains regarding the best treatment approaches, their timing, and dosing.
4. Rehabilitation should provide sufficient amounts and intensity of various types of task practice to reduce functional impairments and teach compensatory strategies. After 24 hours poststroke, moderate to high-intensity exercise and task practice should be performed.
5. Periodic reassessment and re-engagement in therapy at various timepoints are important to inform new therapy targets or approaches and to prevent functional decline.
6. It is critical that care partners receive education and training to support both their own well-being and to maximize the health and rehabilitation of the person for whom they care.
7. Mental health is a key component of successful recovery after stroke. Persons with stroke should be screened for depression and anxiety early after stroke, rescreened at various timepoints, and provided with treatment when needed. Poststroke depression is a common and treatable complication that can interfere with successful rehabilitation as well as quality of life.
8. Telehealth should be considered, particularly when the person with stroke is unable to travel to a clinic for rehabilitation therapies. It can support care transitions and rehabilitation across the continuum after stroke, provide opportunities to improve access, and improve the cost-effectiveness of care.
9. Larger, well-designed clinical trials of rehabilitation interventions are critical to help fill evidence gaps. In particular, continued progress in basic and translational research on nervous system injury and recovery is needed to advance mechanism-based, personalized approaches to stroke rehabilitation.
10. Standardized outcome measures at the body structure/function, activity, and participation levels should be used to identify necessary interventions and document progress. Periodic assessment after rehabilitation discharge is needed to identify areas of decline or new issues that require additional rehabilitation.
11. Secondary complications of immobility, such as skin breakdown and venous thromboembolism, impede poststroke recovery. Current guidance is based on data from hospitalized individuals with impaired mobility with a broad range of conditions. More specific studies of patients receiving rehabilitation at multiple stages of recovery are needed.

PREAMBLE

Since 1990, the American Heart Association (AHA) and American Stroke Association (ASA) have translated scientific evidence into clinical practice guidelines with recommendations to improve cerebrovascular health. These guidelines, which are based on systematic methods to evaluate and classify evidence, provide a foundation for the delivery of quality cerebrovascular care. The AHA and ASA sponsor the development and publication of clinical practice guidelines without commercial support, and members volunteer their time to the writing and review efforts.

Clinical practice guidelines for stroke provide recommendations applicable to patients with or at risk of developing cerebrovascular disease. The focus is on medical practice in the United States, but many aspects are relevant to patients throughout the world. Although it must be acknowledged that guidelines may be used to inform regulatory or payer decisions, the core intent is to improve quality of care and align with patients' interests. Guidelines are intended to define practices meeting the needs of patients in most, but not all, circumstances, and should not replace clinical judgment; furthermore, the recommendations set forth should be considered in the context of individual patient values, preferences, and associated conditions.

The AHA and ASA strive to ensure that guideline writing groups contain requisite expertise and are representative of the broader medical community by selecting experts from a broad array of backgrounds, representing different sexes, races, ethnicities, intellectual perspectives, geographic regions, and scopes of clinical practice, and by inviting organizations and professional societies with related interests and expertise to participate as endorsers. The AHA and ASA have rigorous policies and methods for the development of guidelines that limit bias and prevent improper influence. The complete policy on relationships with industry and other entities can be found at https://professional.heart.org/-/media/phd-files/guidelines-and-statements/policies-devolopment/aha-asa-disclosure-rwi-policy-5118.pdf?la=en.

Beginning in 2017, numerous modifications to the AHA and ASA guidelines have been implemented to make them shorter and to enhance user friendliness. Guidelines are written and presented in a modular knowledge chunk format, in which each chunk includes a table of recommendations, a brief synopsis, recommendation-specific supportive text, and, when appropriate, flow diagrams or additional tables. Other modifications to the guidelines include the addition of Knowledge Gaps and Future Research segments and a web guideline supplement (Data Supplement) for useful but noncritical tables and figures.

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WHAT IS NEW AND OF HIGH IMPACT

This Table highlights selected new and practice-changing recommendations since the last iteration of the guideline and is not a comprehensive list of all updates.

Section/Domain	What Is New and of High Impact
Rehabilitation Across the Continuum	Rehabilitation is conceptualized as a longitudinal process with no defined endpoint, supporting assessment and engagement across the lifespan
	Early supported discharge with coordinated multidisciplinary care is emphasized for appropriate patients
Technology and Telerehabilitation	Increased emphasis on technology-enabled interventions, including telehealth, to improve access, continuity, and efficiency of care
Medical Management of Comorbidities	New section on sleep and poststroke fatigue, including behavioral interventions
	Expanded recommendations for central poststroke pain, including standardized diagnostic criteria and pharmacologic management
	Expanded fall prevention strategies, including structured programs, dual-task training, and tai chi
Mental Health and Behavioral Health	Routine and longitudinal screening for depression and anxiety is recommended
	Expanded mental health recommendations to include both depression and anxiety
Bladder and Bowel Function	Expanded assessment and management strategies, including bladder scanning, timed voiding, pelvic floor training, and electrical stimulation
Hemiplegic Shoulder Pain	Expanded multimodal treatment approach, including neuromodulation, botulinum toxin injections, and adjunct therapies
	Explicit recommendation against the use of overhead pulley exercises due to harm
Assessment	Greater emphasis on standardized, validated assessment tools across motor, cognitive, communication, and sensory domains
	Expanded assessment to include vision, hearing, and perceptual impairments
Sensorimotor Rehabilitation and Function	Updated recommendations on types of task practice and adjuvant techniques
	Expanded guidance on adaptive equipment, orthotics, assistive technology, and lifestyle management
Cognition and Communication	Expanded nonpharmacological approaches for cognitive rehabilitation
	Enhanced recommendations for management of communication disorders, motor speech disorders, and spatial neglect
Transitions of Care and Community Rehabilitation	Strengthened recommendations to ensure continuity of care across settings and into the community
	Expanded focus on caregiver engagement, education, and support
	Increased emphasis on referral to community resources and long-term support services
Participation and Reintegration	Expanded section addressing recreational, leisure, and social participation
	Expanded recommendations for return to work, including individualized vocational rehabilitation
	Expanded recommendations for return to driving with structured safety evaluation

(*Continued*)

1. INTRODUCTION

Stroke remains a leading cause of adult disability. It is responsible for high personal and public costs, with an annual total of $56.2 billion in the United States, including the cost of acute hospital care, rehabilitation, and days of missed work.[1] Rehabilitation plays a key role in reducing disability and promoting quality of life after stroke.

The goal of rehabilitation is for patients with stroke to be restored as closely as possible to normal form and independent functioning, minimizing required assistance and promoting a high quality of life. The overarching framework for rehabilitation is the World Health Organization's (WHO) International Classification of Functioning, Disability and Health (ICF) model, in which functioning is described at the level of impairment of body function and structure (eg, muscles, neural connections), activity limitations (eg, walking, getting dressed, doing laundry), and participation restrictions in one's life roles and community (eg, attending religious activities, being employed, participating in community events, visiting relatives).[2] Functioning is influenced by environmental factors (eg, physical, financial, social) and personal factors (eg, health literacy, age, lifestyle, personal traits). After stroke, impairments from the neural injury (body structure/functional level) cause activity and participation limitations. The severity of these limitations and restrictions are either reduced or inflated by personal and environmental factors. Persons with stroke also cycle through various mood states in a nonlinear fashion. These mood states may impact rehabilitation engagement and response, and rehabilitation activities and progress, among other factors, can influence these mood states. During rehabilitation, clinicians use a variety of intervention strategies with the individual poststroke to minimize impairment and activity limitations and to facilitate re-engagement in life activities and improved quality of life.

It is important to recognize that recovery after stroke is rarely linear, goes beyond physical function, and does not have a clearly defined endpoint. Rather, it is a nonlinear, dynamic process of adaptation in which individuals repeatedly encounter disruption, develop new capacities, reconstruct identity, and gradually reconnect with meaningful roles and relationships.[3,4] This aligns with how many persons with stroke describe their own experiences.[5] Recovery encompasses not only physical and functional gains, but also the ongoing emotional work of adaptation and meaning-making.[6] Recovery is therefore not a return to a previous self but the development of a resilient new self.

Rehabilitation is a longitudinal process taking place across many settings. Rehabilitation begins in the acute hospital setting and continues into a variety of posthospital environments, which can include an inpatient rehabilitation facility (IRF), a skilled nursing facility (SNF), or home with a variety of clinic-based or home health programs. Rehabilitation is provided by both formal caregivers (health professionals or paid caregivers) and informal caregivers (families, partners, and friends). Telerehabilitation is emerging as an alternative platform for home-based treatment. Often rehabilitation continues at home with informal caregivers after formal rehabilitation ends or if no formal rehabilitation was available.

This guideline focuses on codifying the elements of stroke rehabilitation, based on timing across the stroke care continuum, and founded on published evidence when available and expert opinion when gaps in the literature exist. This includes assessments and interventions/programming in the following broad areas: the Rehabilitation Program, Stroke Prevention and Medical Management of Comorbidities, Assessment, Sensorimotor Impairments and Activities, Cognitive and Communication, and Transitions in Care and Community Rehabilitation. Interventions include behavioral interventions, such as task practice, education and counseling; medications; electrical and other types of stimulation; and technology-based interventions. The restorative interventions in these areas are based on reducing neurological impairment through repetitive, high-intensity practice. Pharmacological agents or various types of neural stimulation added to task or other types of practice aim to increase the neuroplasticity potential as well as to treat various complications of stroke (eg, spasticity, depression). Technologies are advancing to assist individuals with stroke to perform task-based practice. Technology may also be used to facilitate more repetitions, provide guidance and enhanced feedback to the nervous system to target impairment, and enhance attention and motivation (eg, through gaming). It can also assist with self-directed practice at home. Compensatory interventions target activity performance, including assistive devices (AD) (eg, a cane or communication board) and learning new techniques to complete activities (eg, 1-handed dressing).

Creating guidelines for rehabilitation is complicated because of the breadth of the field, the multiple disciplines required to provide this care, and the fact that rehabilitation may continue for an extended amount of time without a well-defined endpoint. Traditionally, patients with stroke have been divided into acute, subacute, and chronic stages of recovery, but definitions of these stages have been inconsistent. Based on a recent consensus statement, the current document uses the following definitions to delineate 5 stroke recovery stages: hyperacute: 0 to 24 hours; acute: 1 to 7 days poststroke; early subacute: 7 days to 3 months; late subacute: 3 to 6 months; and chronic: >6 months poststroke.[7] Most of the research on rehabilitation has occurred in the chronic or late subacute phase due to logistical considerations and to avoid the confounders of spontaneous recovery and concurrent standard rehabilitation therapies. In this guideline, we have generally avoided specifying the timing of specific interventions unless there is a particular reason to do so (eg, safety considerations), despite the evidence base containing little data on poststroke interventions at any phase. Another important and neglected issue is intervention dosing (ie, intensity, schedule, amount). These parameters vary widely among studies, and dosing comparisons have seldom been performed. Therefore, dosing has largely been omitted from recommendations unless there is clear evidence for a particular dose(s). AHA policy has evolved since the prior Stroke Rehabilitation Guidelines were released, and based on this updated policy, these guidelines intentionally omit recommendations that incorporate devices or medications that are not specifically indicated by the US Food and Drug Administration (FDA) for use in stroke recovery. Instead, these topics are included in the text as areas with knowledge gaps for further research. Previously recommended medications and technologies in prior guidelines are "grandfathered" for inclusion. For some areas, other detailed recommendations already exist in other AHA guidelines (eg, for secondary stroke prevention). In these cases, we have referred the user to these other guidelines rather than duplicating the recommendations. Additionally, barriers to access and equity in rehabilitation services are

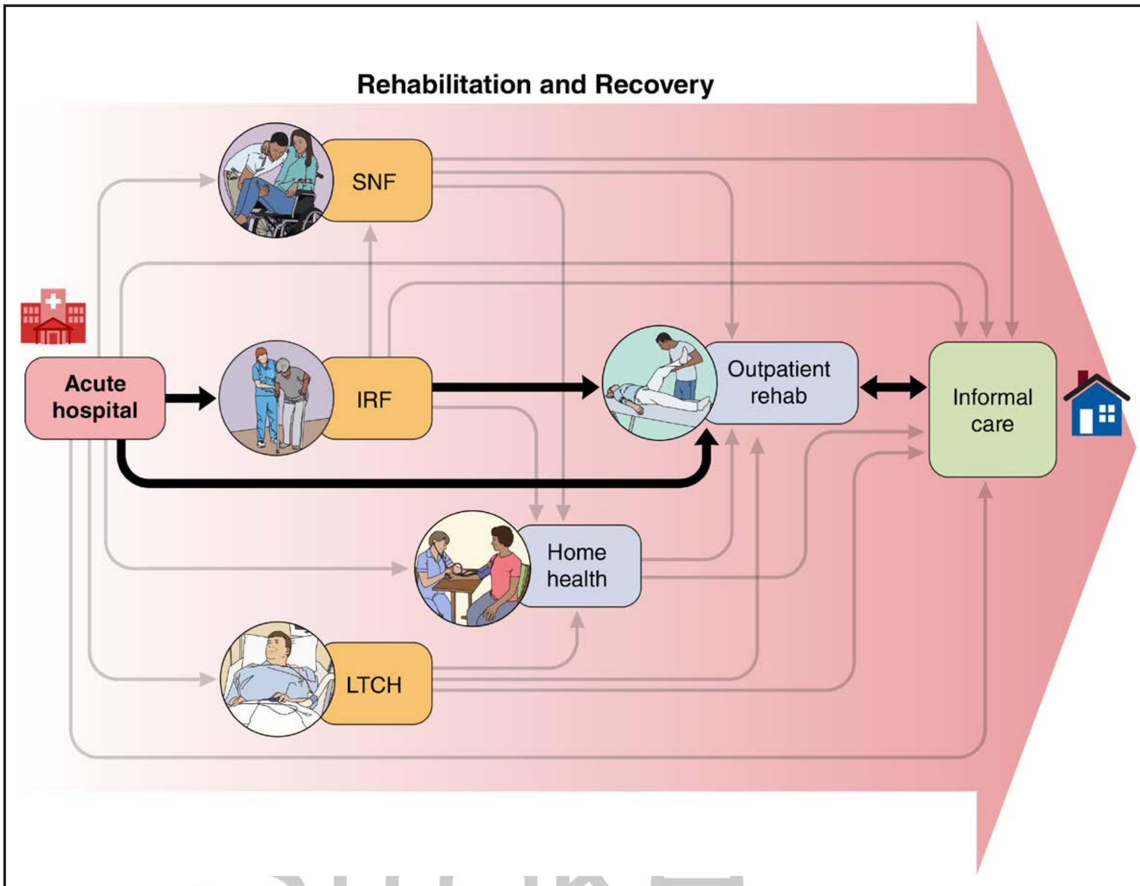

Figure 1. The path from acute stroke through rehabilitation and recovery.
Paths vary substantially, with some individuals returning directly home from the hospital, and others requiring extensive postacute care. Outcomes differ, with some individuals requiring long-term care, while others achieve a full recovery and community independence. Many individuals have residual functional impairments, requiring formal or informal caregiver support. IRF indicates inpatient rehabilitation facility; LTCH, long-term care hospital; and SNF, skilled nursing facility.

not addressed within this document; instead, readers are referred to *Improving Access to Stroke Rehabilitation and Recovery: A Policy Statement From the American Heart Association/American Stroke Association* for guidance.[8]

This guideline uses the framework established by the AHA for selecting both the class of recommendation (COR) and the supporting level of evidence (LOE) (Tables 1 and 2). We have attempted to limit recommendations to those that are relatively feasible in the US health care system. It should be emphasized that the COR level is made on the basis of *potential benefit compared to risk to the person with stroke*, leading to some CORs that are higher than one might expect if these were based solely on the strength of evidence. As such, these guidelines represent the state of the evidence at present (through Fall 2025), and forthcoming evidence may alter future recommendations. Thus, users should stay abreast of new evidence in the field. It is also important to remember that the majority of this evidence is based on research with group designs, reflecting general trends. As always, users must consider the uniqueness of the situation of each person with stroke when applying this guideline. Continued progress in basic and translational research on nervous system injury and recovery is needed to advance mechanism-based, personalized approaches to stroke rehabilitation.

METHODOLOGY AND EVIDENCE REVIEW

The recommendations listed in this guideline are, whenever possible, evidence-based and supported by extensive evidence review. A search for literature derived from research principally involving human subjects, published in English since the last Guidelines for Adult Stroke Rehabilitation and Recovery guideline in 2016, and indexed in MEDLINE, PubMed, Cochrane Library, and other selected databases relevant to this guideline, was conducted between June and October 2025. (Additional studies and articles were added later, where appropriate.) The Data Supplement contains the final evidence tables summarizing the evidence used by the Guideline Writing Group to formulate recommendations. Additionally, the Guideline Writing Group reviewed documents related to subject matter previously published by the AHA and ASA (Table 1). References selected and published in the present document are representative and not all-inclusive.

Table 1. Associated AHA/ASA Guidelines and Statements

Title	Organization	Publication year
AHA/ASA Guidelines		
Guidelines for Adult Stroke Rehabilitation and Recovery: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association	AHA/ASA	2016[9]
2021 Guideline for the Prevention of Stroke in Patients With Stroke and Transient Ischemic Attack: A Guideline From the American Heart Association/American Stroke Association	AHA/ASA	2021[10]
2024 Guideline for the Primary Prevention of Stroke: A Guideline From the American Heart Association/American Stroke Association	AHA/ASA	2024[11]
2026 Guideline for the Early Management of Patients With Acute Ischemic Stroke: A Guideline From the American Heart Association/American Stroke Association	AHA/ASA	2026[12]
AHA/ASA Scientific Statements		
2024 Heart Disease and Stroke Statistics: A Report of US and Global Data From the American Heart Association	AHA	2024[1]
Alcohol Use and Cardiovascular Disease: A Scientific Statement From the American Heart Association	AHA	2025[13]
Call to Action to Prevent Venous Thromboembolism in Hospitalized Patients: A Policy Statement From the American Heart Association	AHA	2020[14]
Care of the Patient With Acute Ischemic Stroke (Endovascular/Intensive Care Unit-Postinterventional Therapy): Update to 2009 Comprehensive Nursing Care Scientific Statement: A Scientific Statement From the American Heart Association	AHA	2009[15]
Comprehensive Overview of Nursing and Interdisciplinary Rehabilitation Care of the Stroke Patient: A Scientific Statement From the American Heart Association	AHA	2010[16]
Management of Infective Endocarditis in People Who Inject Drugs: A Scientific Statement From the American Heart Association	AHA	2022[17]
Multidimensional Sleep Health: Definitions and Implications for Cardiometabolic Health: A Scientific Statement From the American Heart Association	AHA	2025[18]
An Overview of Telehealth in the Management of Cardiovascular Disease: A Scientific Statement From the American Heart Association	AHA	2022[19]
Physical Activity and Exercise Recommendations for Stroke Survivors: A Statement for Healthcare Professionals From the American Heart Association/American Stroke Association	AHA	2014[20]
Venous Thromboembolism Research Priorities: A Scientific Statement From the American Heart Association and the International Society on Thrombosis and Haemostasis	AHA/ISTH	2020[21]

AHA indicates American Heart Association; ASA, American Stroke Association; and ISTH, International Society on Thrombosis and Haemostasis.

Each topic area was assigned a primary writer, as well as a primary, and sometimes secondary, reviewer. These assignments were based on the areas of expertise of the members of the Guideline Writing Group and their lack of any relationships with industry related to the section material. All recommendations were fully reviewed and discussed among the full group to allow for diverse perspectives and considerations for this guideline. Recommendations were then voted on, and a modified Delphi process was used to reach consensus. Guideline Writing Group members who had relationships with industry that were relevant to certain recommendations were recused from voting on those particular recommendations. All recommendations in this guideline were agreed to by between 82.2% and 100% of the voting Guideline Writing Group members.

Organization of the Guideline Writing Group

The Guidelines for Adult Stroke Rehabilitation and Recovery Guideline Writing Group consisted of vascular and stroke neurologists, physical medicine and rehabilitation physicians, physical therapists, occupational therapists, speech-language pathologists, a recreation therapist, nurses, a fellow-in-training, and 2 patient representatives. The writing group included representatives from the AHA and ASA, American Academy of Neurology (AAN), American Academy of Physical Medicine and Rehabilitation (AAPM&R), American Congress of Rehabilitation Medicine (ACRM), American Occupational Therapy Association (AOTA), American Physical Therapy Association (APTA), American Speech-Language-Hearing Association (ASHA), American Therapeutic Recreation Association (ATRA), and Association of Rehabilitation Nurses (ARN). Appendix 1 of this document lists Guideline Writing Group members' relevant Relationships With Industry (RWI) and other entities. For the purposes of full transparency, the Guideline Writing Group members' comprehensive disclosure information is available online (***insert URL link at publication***).

Document Review and Approval

This document was reviewed by the AHA's Stroke Scientific Statements Oversight Committee, AHA's Science Advisory and Coordinating Committee, AHA's Executive Committee, reviewers from the AAN, AAPM&R, ACRM, AOTA, APTA, ASHA, American Society of Neurorehabilitation, ATRA, and ARN, as well as by 33 individual content reviewers. Appendix 2 lists reviewers' comprehensive disclosure information.

Table 2. Applying Class of Recommendation and Level of Evidence to Clinical Strategies, Interventions, Treatments, or Diagnostic Testing in Patient Care

CLASS (STRENGTH) OF RECOMMENDATION

Class 1 (STRONG) — **Benefit >>> Risk**

Suggested phrases for writing recommendations:

- Is recommended
- Is indicated/useful/effective/beneficial
- Should be performed/administered/other
- Comparative-Effectiveness Phrases†:
  - Treatment/strategy A is recommended/indicated in preference to treatment B
  - Treatment A should be chosen over treatment B

Class 2a (MODERATE) — **Benefit >> Risk**

Suggested phrases for writing recommendations:

- Is reasonable
- Can be useful/effective/beneficial
- Comparative-Effectiveness Phrases†:
  - Treatment/strategy A is probably recommended/indicated in preference to treatment B
  - It is reasonable to choose treatment A over treatment B

Class 2b (WEAK) — **Benefit ≥ Risk**

Suggested phrases for writing recommendations:

- May/might be reasonable
- May/might be considered
- Usefulness/effectiveness is unknown/unclear/uncertain or not well-established

Class 3: No Benefit (MODERATE) (Generally, LOE A or B use only) — **Benefit = Risk**

Suggested phrases for writing recommendations:

- Is not recommended
- Is not indicated/useful/effective/beneficial
- Should not be performed/administered/other

Class 3: HARM (STRONG) — **Risk > Benefit**

Suggested phrases for writing recommendations:

- Potentially harmful
- Causes harm
- Associated with excess morbidity/mortality
- Should not be performed/administered/other

LEVEL (QUALITY) OF EVIDENCE‡

Level A

- High-quality evidence‡ from more than 1 RCT
- Meta-analyses of high-quality RCTs
- One or more RCTs corroborated by high-quality registry studies

Level B-R — **(Randomized)**

- Moderate-quality evidence‡ from 1 or more RCTs
- Meta-analyses of moderate-quality RCTs

Level B-NR — **(Nonrandomized)**

- Moderate-quality evidence‡ from 1 or more well-designed, well-executed nonrandomized studies, observational studies, or registry studies
- Meta-analyses of such studies

Level C-LD — **(Limited Data)**

- Randomized or nonrandomized observational or registry studies with limitations of design or execution
- Meta-analyses of such studies
- Physiological or mechanistic studies in human subjects

Level C-EO — **(Expert Opinion)**

- Consensus of expert opinion based on clinical experience

COR and LOE are determined independently (any COR may be paired with any LOE).

A recommendation with LOE C does not imply that the recommendation is weak. Many important clinical questions addressed in guidelines do not lend themselves to clinical trials. Although RCTs are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.

* The outcome or result of the intervention should be specified (an improved clinical outcome or increased diagnostic accuracy or incremental prognostic information).

† For comparative-effectiveness recommendations (COR 1 and 2a; LOE A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

‡ The method of assessing quality is evolving, including the application of standardized, widely-used, and preferably validated evidence grading tools; and for systematic reviews, the incorporation of an Evidence Review Committee.

COR indicates Class of Recommendation; EO, expert opinion; LD, limited data; LOE, Level of Evidence; NR, nonrandomized; R, randomized; and RCT, randomized controlled trial.

Scope of the Guideline

In the process of developing this guideline, the writing group reviewed previously published the AHA and ASA guidelines and scientific statements listed in Table 1. These are resources for readers that reduce the need for repetition of existing guideline recommendations.

COR and LOE

Recommendations are designated with both a COR and an LOE. The COR indicates the strength of recommendation, encompassing the estimated magnitude and certainty of benefit in proportion to risk. The LOE rates the quality of scientific evidence supporting the intervention based on the type, quantity, and consistency of data from clinical trials and other sources (Table 2).

Abbreviations

Abbreviation	Meaning
AAC	Augmentative and Alternative Communication
ACT	Acceptance and Commitment Therapy
AD	Assistive Devices
ADL/ADLs	Activities of Daily Living
AFO	Ankle-Foot Orthosis
AHA	American Heart Association
AAN	American Academy of Neurology
AAPM&R	American Academy of Physical Medicine and Rehabilitation
ACRM	American Congress of Rehabilitation Medicine
ASA	American Stroke Association
ASHA	American Speech-Language-Hearing Association
AOTA	American Occupational Therapy Association
APTA	American Physical Therapy Association
ARN	Association of Rehabilitation Nurses
ATRA	American Therapeutic Recreation Association
BDI-II	Beck Depression Inventory-II
BOA	Behavioural Outcomes of Anxiety Scale
CBT	Cognitive Behavioral Therapy
CIMT	Constraint-Induced Movement Therapy
COR	Class of Recommendation
CPSP	Central Poststroke Pain
DM/Q	Dextromethorphan/Quinidine
DVT	Deep Vein Thrombosis
ESD	Early Supported Discharge
ESWT	Extracorporeal Shock Wave Therapy
FDA	Food and Drug Administration
FES	Functional Electrical Stimulation
GDS	Geriatric Depression Scale
GSC	Guided Self-Rehabilitation Contract
HADS	Hospital Anxiety and Depression Scale
HDRS	Hamilton Depression Rating Scale
HILT	High-Intensity Laser Therapy
HSP	Hemiplegic Shoulder Pain
IADL/IADLs	Instrumental Activities of Daily Living
ICF	International Classification of Functioning, Disability and Health
ICH	Intracranial Hemorrhage
IPC	Intermittent Pneumatic Compression
IRF	Inpatient Rehabilitation Facility
ITB	Intrathecal Baclofen
LMWH	Low-Molecular-Weight Heparin
LOE	Level of Evidence
MADRS	Montgomery–Åsberg Depression Rating Scale
MAS	Modified Ashworth Scale
MMSE	Mini-Mental State Examination
MoCA	Montreal Cognitive Assessment
mRS	Modified Rankin Scale
NDT	Neurodevelopmental Therapy
NIHSS	National Institutes of Health Stroke Scale
NMES	Neuromuscular Electrical Stimulation
OCS	Oxford Cognitive Screen
PBA	Pseudobulbar Affect
PE	Pulmonary Embolism
PEG	Percutaneous Endoscopic Gastrostomy
PFMT	Pelvic Floor Muscle Training
PHQ	Patient Health Questionnaire
PHQ-2	Patient Health Questionnaire-2
PHQ-9	Patient Health Questionnaire-9
PNS	Peripheral Nerve Stimulation
PRF	Pulsed Radiofrequency Neuromodulation
PSA	Poststroke Anxiety
PSD	Poststroke Depression
RAGT	Robot-Assisted Gait Training
RCT	Randomized Controlled Trial
ROM	Range of Motion
rTMS	Repetitive Transcranial Magnetic Stimulation
SADQ	Stroke Aphasia Depression Questionnaire
SNF	Skilled Nursing Facility
SSNB	Suprascapular Nerve Block
SSRI/SSRIs	Selective Serotonin Reuptake Inhibitor(s)
tDCS	Transcranial Direct Current Stimulation
TENS	Transcutaneous Electrical Nerve Stimulation
UFH	Unfractionated Heparin
VAMS	Visual Analog Mood Scale
D-VAMS	Dynamic Visual Analog Mood Scales
VNS	Vagus Nerve Stimulation
VR	Virtual Reality
VTE	Venous Thromboembolism
WHO	World Health Organization
WHODAS	World Health Organization Disability Assessment Schedule

(*Continued*)

2. THE REHABILITATION PROGRAM

2.1. Organization of Poststroke Rehabilitation Care (Levels of Care)

Recommendations for Organization of Poststroke Rehabilitation Care (Levels of Care)
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
Postacute Rehabilitation Care		
1	A	1. In persons with stroke who are candidates for postacute rehabilitation, organized, coordinated, interprofessional care is recommended to achieve maximal functional independence.[1,2]
1	B-NR	2. In persons with stroke who qualify for IRF care, treatment in an IRF in preference to a SNF is recommended to achieve more functional improvement by discharge and higher rates of community discharge.[3–7]
1	C-LD	3. In persons with stroke seeking outpatient or home-based rehabilitation, organized community-based and coordinated interprofessional rehabilitation care is recommended to achieve more functional improvement.[8,9]
2a	C-LD	4. In persons with stroke who are unable to return directly home after hospitalization and do not qualify for or lack geographic access to IRF care, SNF care can be useful for individuals to achieve additional functional improvement.[10]
2a	C-EO	5. In persons with stroke who have completed care in an IRF but are unable to return directly home because of ongoing rehabilitation needs, medical requirements, or personal care needs, SNF care can be useful to achieve more functional improvement.
Early Supported Discharge		
1	B-R	6. In persons with stroke with mild to moderate activity limitations, early supported discharge with multidisciplinary services is recommended to achieve comparable outcomes to hospital-based rehabilitation.[11–14]
3: No Benefit	B-R	7. For persons with stroke, early discharge with family-led home-based rehabilitation has no impact on outcome compared with early discharge alone.[15–17]

Synopsis

Access to high-quality postacute rehabilitation care is necessary for individuals who have experienced a stroke to have better functional outcomes.[18] In the United States, postacute rehabilitation occurs across different types of facilities that offer varying levels of physician, rehabilitation therapy, and nursing care. For persons with stroke with moderate to significant self-care and mobility limitations, inpatient programs include IRFs and SNFs. IRFs provide the highest amount of rehabilitation therapy per day, at least 3 hours of therapy 5 days per week, care from rehabilitation nurses, and daily physician visits. SNFs ("subacute rehabilitation") offer patients nursing and therapy, but the amount of therapy is not predetermined, and physician oversight is typically not daily, direct supervision.

In a recent study of Medicare fee-for-service beneficiaries with stroke who were discharged from an acute care hospital, 35% did not receive any postacute care, 28% were discharged to an IRF, 24% were discharged to an SNF, and 13% were discharged with care from a home health agency.[19] It should be noted that, as this study did not include outpatient rehabilitation, the percentage who did not receive any postacute care may be overestimated.

For persons with stroke who have less severe functional deficits, community-based services include home health agencies, which offer nursing and therapy services for patients who have difficulty leaving home without assistance, and outpatient clinics. Some facilities offer "day rehabilitation" programs as an outpatient service, which involves coordinated care from 2 or more disciplines.

For persons with stroke with complex medical needs, care in a long-term care hospital may be appropriate. Long-term care hospitals offer medical and nursing care for extended periods, maintaining average stays of at least 25 days and offering some rehabilitation therapy.

Early supported discharge (ESD) following stroke has been studied in Europe, Australia, and New Zealand for >20 years. For selected individuals with mild to moderate impairments after stroke, ESD to a home for ongoing rehabilitation has the capacity to yield outcomes comparable to inpatient rehabilitation. This approach integrates hospital care with community services and a multidisciplinary rehabilitation team. Evidence shows that ESD services for people with acute stroke help patients leave the hospital sooner and continue coordinated multidisciplinary rehabilitation at home.[11] Because the US health care system differs from that of Europe, the available data correlate with typical US practices because acute hospital length of stay is shorter after stroke, and many patients with less severe stroke receive rehabilitation in a clinic or in their homes after hospital discharge, reflecting a pattern of care similar to the ESD model.[20]

Recommendation-Specific Supportive Text

1. Optimal stroke rehabilitation requires a multidisciplinary team including physiatrists or neurologists with rehabilitation expertise, rehabilitation nurses, occupational therapists, physical therapists, speech-language pathologists, social workers, and psychologists, among others.[2] During acute hospitalization, the focus is on medical stabilization and acute stroke treatment, though evidence supports starting rehabilitation therapy as soon as patients can tolerate it (see section 2.2 for limitations specific to high-intensity early mobilization). Acute care stays in the United States are short, and all patients should receive a formal assessment of rehabilitation needs from therapy services before discharge.[1]

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2. Observational studies have consistently demonstrated superior functional outcomes for patients with stroke discharged to IRFs versus SNFs.[4,21] Using data from selected states, Bako et al[22] found lower odds of major adverse cardiovascular events in patients at IRFs compared with SNFs in their study of intracerebral hemorrhage survivors. In a study of Medicare fee-for-service beneficiaries with stroke, Simmonds et al found that those who received postacute care in IRFs had higher rates of 1-year community living and lower 1-year mortality.[23] After risk adjustment, patients referred to IRFs had a lower occurrence of these events compared with those in SNFs.

   The systematic review by Alcusky et al[3] found that across multiple studies, patients in IRFs had higher community discharge rates, lower readmission rates, and better survival compared with patients in SNFs. In examining functional outcomes, this review mistakenly classified 1 study as comparing IRF and SNF care when it actually compared subacute rehabilitation programs in different settings.[24] After excluding this study, the 4 remaining studies reported better functional outcomes for patients at IRFs. Two studies reported higher costs of IRFs.

   The observational studies comparing IRF and SNF outcomes are inherently limited by their nonrandomized nature, baseline differences in the populations of patients with stroke receiving rehabilitation in these 2 settings, and concerns about unmeasured confounders that persist even after statistical corrections to account for baseline differences in the characteristics of patients and selection bias. Hong et al examined multiple different statistical adjustments to account for unmeasured confounders, including instrumental variable analysis and propensity scores, and found that the relative advantages of IRF relative to SNF persisted.[4] Overall, despite the limitations of observational studies, the consistency of the study results across multiple studies supports IRF care as the preferred option for appropriate patients with stroke.

   In a study of Medicare fee-for-service beneficiaries with stroke, Simmonds et al found that those who received postacute care in IRFs had higher rates of 1-year community living and lower 1-year mortality.[23] After risk adjustment, patients referred to IRFs had the lowest occurrence of these events compared with those in SNFs. The observational studies comparing IRF and SNF outcomes all had methodological limitations despite the authors' attempts to account for baseline differences in the characteristics of patients and selection bias.[4] Overall, the consistency of the results across multiple studies supports IRF care as the preferred option for appropriate patients with stroke.

3. A Cochrane review that included 14 trials and 1617 patients with stroke who received outpatient rehabilitation therapy services reported reduced odds of a poor outcome (Peto odds ratio, 0.72 [95% CI, 0.57–0.92]; P=0.009) and increased personal activity of daily living scores (standardized mean difference, 0.14 [95% CI, 0.02–0.25]; P=0.02).[8] A more recent study found that after controlling for demographic, clinical, and health differences, persons with stroke who received outpatient therapy in the first 30 days after discharge home were less likely to be readmitted to the hospital in the subsequent 30 days compared with those who received no therapy.[9]

4. Many persons with stroke are admitted to SNFs rather than IRFs for postacute rehabilitation care. This includes patients with limited rehabilitation potential, those unable to tolerate intensive therapy due to frailty or comorbidities, or those with medical needs. Stein et al[10] surveyed experts representing various clinical discipline, policy, and insurance perspectives to identify key factors influencing the selection of postacute level of care for patients with stroke and reported percentages of expert support for the following criteria: likelihood to benefit from an active rehabilitation program (97%), need for clinicians with specialized rehabilitation skills (94%), need for active and ongoing medical management and monitoring (84%), ability to tolerate an active rehabilitation program (74%), need for caregiver training to return to the community (48%), family/caregiver support (39%), likelihood to return to community/home (39%), ability to return to physical home environment (32%), and premorbid dementia (16%).

   With approximately 15 000 SNFs and 1100 IRFs in the United States, SNFs are more geographically accessible than IRFs, making them necessary for patients lacking convenient access to IRF care.[25,26] Furthermore, there are also some patients whose insurance plans lack IRF coverage or have criteria favoring SNF care, so these patients receive SNF care. Ifejika et al[18] and Vabson et al[27] described barriers to accessing postacute rehabilitation care for Medicare beneficiaries who have Medicare Advantage coverage, due to preauthorization requirements.

5. Sequential postacute rehabilitation care utilization is increasingly occurring as a result of the postacute care prospective payment systems that incentivize short stays. For example, persons with stroke may complete an initial rehabilitation at an IRF before transitioning to a SNF prior to discharge home to address ongoing rehabilitation needs, medical requirements, or personal care needs to achieve more functional improvement.[28]

6. A 2017 Cochrane review of 17 trials (2422 patients) found that ESD for stroke reduced

hospital stays by approximately 5 days, improved independence in daily activities, and increased the likelihood of living at home, without increasing readmission rates or negatively affecting quality of life or caregiver mood.[11] Benefits were most notable in patients with moderate disability who could ambulate with assistance, particularly when ESD was delivered by a coordinated multidisciplinary team. Cost outcomes ranged from slightly reduced to modestly increased compared with standard care. A 2022 systematic review and meta-analysis showed only a trend toward reduced hospital stays, and there were no adverse effects on mortality, readmission, or activities of daily living (ADLs).[14] Many studies focused on patients with milder strokes, potentially limiting the detection of subtle functional gains due to a ceiling effect. The heterogeneity of ESD interventions used across studies may have influenced these results. While ESD is effective in certain contexts, such as in Europe, its applicability in health care systems with shorter hospital stays—such as in the United States—requires careful adaptation to local practice models.[12,13]

7. Current evidence shows that in countries with fewer health care resources or in rural settings with limited access to home health or outpatient rehabilitation services, family-led rehabilitation care is not effective, despite the provision of education prior to hospital discharge and supportive contact after discharge. The Family-led Rehabilitation after Stroke in India (ATTEND) trial investigated whether family-led rehabilitation for patients with stroke in India could outperform usual care in improving outcomes after stroke.[15] Conducted across 14 hospitals, 1200 adults who recently had a stroke and had a nominated caregiver were randomized to either an intervention group that received structured rehabilitation training for family members (including goal setting and task-specific activities) or a usual care group. Rehabilitation began in the hospital and continued at home for 2 months. After 6 months, the trial found no significant difference in death or dependency rates between the family-led rehabilitation group and those receiving standard care, suggesting that in low-resource settings such as India, where access to professional rehabilitation is limited, simply training family members may not be enough to improve stroke recovery outcomes. These findings suggest that health care policies should support equitable access to postacute rehabilitation services in underserved areas.[18]

Knowledge Gaps and Future Research

- Future research is needed to better understand the long-term outcomes and costs associated with different postacute care utilization patterns. The fragmented health care system, the various postacute rehabilitation care options, and the varying prospective payment systems and their associated incentives create challenges for ensuring quality, timely, and equitable rehabilitation services.
- There is a need for validated decision support tools that account for stroke severity, comorbidities, cognitive status, social support, and rehabilitation potential to determine postacute setting, optimal amount of daily therapy, and duration of therapy.
- Care delivery improvements could focus on the role of telemedicine and the role of alternative payment models, as well as improved handoffs when patients transition from different care settings.
- Additional research should focus on team functioning, such as optimal team composition and functioning across different settings; training needs for therapists, nurses, and physicians in stroke-specific rehabilitation; and the impact of rehabilitation nursing on outcomes.

2.2. Rehabilitation Interventions in the Inpatient Acute Hospital Setting

Recommendations for Rehabilitation Interventions in the Inpatient Acute Hospital Setting
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	A	1. In persons with stroke in the acute phase, early mobilization should be undertaken using a graduated mobilization protocol that commences 24 to 48 hours after stroke onset to improve functional outcomes and quality of life.[1–5]
3: Harm	A	2. In persons with acute stroke, high-dose mobilization within the first 24 hours after stroke onset should not be performed to avoid risk of neurological worsening and worsened functional outcomes.[6]

Synopsis

Starting rehabilitation in the acute hospital setting after stroke is important both to prevent and treat complications and improve functional independence.

Recovery after stroke is influenced by several variables, including medical complications stemming from immobility.[7,8] Early, out-of-bed mobilization is among the best studied aspects of rehabilitation in this setting, though the timing and intensity of mobilization have varied widely in the literature and in practice. Mobilization in the acute phase after a stroke, and repeating these activities until the patient's discharge, can improve overall neurological recovery. Furthermore, mobilization reduces medical complications such as pneumonia, deep vein thrombosis, pressure ulcers, contracture formation, and constipation.[9]

However, mobilization that is too early or too intense can pose risks to the patient. The clear benefits of early

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mobilization must be weighed against these potential risks, which include hemodynamic changes with positioning and exertion that might worsen acute cerebral ischemia and therefore, eventual functional outcomes.[10–12]

Recommendation-Specific Supportive Text

1. Mobilization between 24 and 48 hours after stroke onset is often referred to as "early mobilization," whereas "very early" mobilization[1] generally occurs before 24 hours. Early mobilization has been shown to improve quality of life and functional outcomes without the potential risks associated with activity in the hyperacute or "very early" phase.

   As an intervention, early mobilization is typically delivered through structured, graduated protocols (see Figure 1) and can be accomplished by physical and occupational therapists, nursing staff, and even trained family members.[1,2,4–6,13,14] The modality or intensity of activity is also variable across several studies but goes beyond the standard of care, with prioritization of out-of-bed movements. These randomized trial data suggest that several approaches are successful in supporting patient recovery, and practical logistics should be prioritized.
2. Though early mobilization has an important role in stroke recovery, initiating very early mobilization may lead to adverse outcomes, with some patients at higher risk than others. In the largest randomized controlled trial (RCT) in this space to date, higher-frequency and very early (median, 18.5 hours poststroke) mobilization was associated with a decrease in the odds of a favorable 3-month outcome on the modified Rankin Scale (mRS).[6] This was especially true for patients mobilized at <12 hours and at a higher intensity (longer, more frequent sessions). Patients with worse National Institutes of Health Stroke Scale (NIHSS) scores, intracerebral hemorrhage, and impaired consciousness were among the most vulnerable to harm from very early mobilization. Higher-intensity mobilization sessions were associated with higher metabolic demand, hemodynamic instability, and risk of neurological deterioration.[6] These data suggest that indiscriminate use of very early mobilization (ie, within first 24 hours poststroke) is not advised, though graduated early mobilization (initiated between the first 24–48 hours) is recommended.

Knowledge Gaps and Future Research

- Data are disproportionately centered on the ischemic stroke population. Prospective data with large intracerebral hemorrhage populations are needed.
- Ischemic stroke subtypes: in the ischemic stroke population, differential effects by stroke subtype deserve further exploration.
- There are several modalities used in the postacute setting, such as electrical stimulation, bed-based resistance exercise, and body-weight support devices, that do not have evidence for utility, feasibility, or efficacy in stroke recovery in the acute setting. Comparative efficacy of these modalities should be studied in this population.
- Theories for why VEM is harmful in certain populations remain speculative and include cerebral autoregulation, hemodynamic and cardiac insufficiency, and increased metabolic demand. These mechanisms need validation in human studies.
- Current data point toward beneficial windows (24–48 hours) and harmful intensities, but no optimal dose of mobilization has been established in any stroke population. Further studies to support a specific dose-based protocol are needed.
- Bed-based versus out-of-bed mobilization: Early mobilization data almost exclusively focus on a progressive pattern in which bed-based activity is ideally followed by out-of-bed movements. More studies looking at exclusively in-bed mobilization versus exclusively out-of-bed mobilization might further differentiate risk and benefit.

3 PREVENTION AND MEDICAL MANAGEMENT OF COMORBIDITIES

3.1. Prevention of Skin Breakdown and Contractures

Recommendations for the Prevention of Skin Breakdown and Contractures
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
Prevention of Skin Breakdown		
1	A	1. In persons with acute stroke, regular skin assessments are recommended during acute hospitalization and postacute care using valid measurement instruments (eg, the Braden Scale) to monitor for skin breakdown.[1–3]
1	A	2. In persons with stroke and limited mobility, skin friction should be minimized through the use of foam dressings and durable medical equipment such as pressure-reducing supporting surfaces, reduction of moisture, and maintenance of adequate nutrition and hydration to reduce the occurrence of skin breakdown.[1–10]
1	B-R	3. Persons with stroke, caregivers, and clinical staff should be educated about the prevention of skin breakdown among persons with stroke and limited mobility.[11–14]
Prevention of Contractures		
2a	B-NR	4. In persons with poststroke spasticity of upper or lower limbs, programs encouraging stretching are reasonable to improve neural, mechanical, and structural changes in involved muscle regions and to prevent contracture.[15,16]

Recommendations for the Prevention of Skin Breakdown and Contractures (Continued)

COR	LOE	Recommendations
2b	C-LD	5. In persons with stroke and hemiplegia, positioning of the hemiplegic shoulder in external rotation, with pain-free shoulder abduction and elbow extension twice daily for 30 min while the patient is sitting or in bed may be reasonable to minimize contracture.[17,18]
2b	B-NR	6. In persons with stroke and hemiplegia affecting the lower limb, wearing resting ankle splints when in bed may be considered to prevent contracture.[19]
2b	B-R	7. In persons with stroke and mild to moderate elbow and wrist contractures, use of serial casting or static adjustable splints may be considered to reduce contractures.[20,21]
2b	C-LD	8. In persons with substantial elbow contractures and pain, surgical release of brachialis, brachioradialis, and biceps muscles may be considered to reduce pain and improve mobility.[22]

Synopsis

Changes in sensory perception, voluntary movement abilities, and cognition increase risk for skin breakdown and contractures among persons with stroke who experience these changes. Pressure injury and bruising may occur in up to 17% to 25% of hospitalized patients with stroke.[23,24] After stroke with hemiparesis, up to half of survivors will develop contractures, putting the affected limb also at risk for skin breakdown.[23,25] There is limited evidence to guide recommendations for prevention of skin breakdown specifically for persons with stroke with limited mobility;[4,26,27] thus, recommendations rely on best practices for maintaining skin integrity from the robust body of evidence for pressure injury prevention across populations with limited mobility.[1–6,26,27] For prevention of contractures, there have been a few small trials to guide recommendations.[15–22] These trials test interventions to promote mobility and to reduce spasticity and, ultimately, contractures.

Recommendation-Specific Supportive Text

1. Regular assessment of skin is an important responsibility for nursing and other rehabilitation team staff. Assessment should be completed every shift for inpatient units, with repositioning, paying close attention to skin on the hemiplegic side. Skin assessment should be completed using objective scales of risk such as the Braden Scale, with appropriate documentation and follow-up for areas of concern.[1–3,26]
2. AHA guidelines for care of persons with stroke recommend minimizing or eliminating friction, minimizing pressure, providing appropriate support surfaces, avoiding excessive moisture, and maintaining adequate nutrition and hydration.[1,2,26,27] Seminal and recent reviews in populations that extend beyond stroke have highlighted the importance of these practices.[1–3,5–10] Many products, such as foam dressings, can be added to pressure points to reduce friction and allow the skin to recover.[9,10] Additionally, pressure-reducing supporting surfaces such as specialty mattresses and wheelchair cushions are recommended to prevent skin breakdown or worsening skin injury.[1–8,26]
3. AHA guidelines also recommend educating patients, caregivers, and clinical staff (see section 7.2) about the prevention of skin breakdown among persons with stroke and limited mobility.[3,27] In the broader literature regarding pressure injury prevention, several reviews and studies have highlighted the importance of educating patients, caregivers, and clinicians.[11–14]
4. Two recent trials[15,16] add to prior trial evidence[28–30] that demonstrate the importance of stretching programs to prevent contracture. In a small, single-blinded, randomized control trial (n=45), participants were randomized 2:1.[15] The larger experimental group participated in a functional stretching program 3 times per week over 4 weeks. Trial results favored the intervention, suggesting that the stretching program improved neural and mechanical properties of the spastic medial gastrocnemius muscle in patients with chronic stroke. In another trial, persons with stroke with hemiparesis were randomized into 1-year rehabilitation programs, with either conventional therapy supplemented with the Guided Self-rehabilitation Contract (GSC) program or conventional therapy alone.[16] Daily self-stretch of the soleus and gastrocnemius over 1 year, using the program combined with conventional rehabilitation, increased muscle fascicle length, extensibility, and ambulation speed more than conventional rehabilitation alone.
5. Two trials[17,18] tested interventions to increase shoulder mobility for persons with stroke on the side affected by hemiplegia. In the first trial (N=36), the experimental group received 2 30-minute sessions per day, 5 days per week for 4 weeks, during which the affected upper limb was placed in maximum comfortable external rotation and 90 degrees of flexion.[17] Both the experimental and control groups received up to 10 minutes of shoulder exercises and standard upper-limb care. The 30-minute program of positioning the shoulder in maximum external rotation significantly reduced the development of contractures in the experimental group compared with the control group. In another trial (N=19), the experimental group similarly received shoulder and arm positioning procedures for 2 30-min sessions each day, 5 days per week for 5 weeks, in addition to usual rehabilitation care.[18]

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The intervention slowed the development of shoulder abduction contracture compared with controls.

6. A small trial (N=30) tested 2 different interventions to prevent ankle contracture.[19] One group wore a splint on the affected ankle nightly to keep the ankle in plantigrade; the second group stood on a tilt table for 30 minutes with the ankle in dorsiflexion 5 times per week. While the 2 groups had similar benefits in preventing ankle contracture, the ankle splint is more manageable in the home.
7. In patients who developed contractures, serial casting or use of adjustable splints may be beneficial in preventing elbow or wrist contractures, though data are conflicting across 2 clinical trials.[20,21]
8. One study (N=29) followed outcomes of surgical release of the brachialis, brachioradialis, and biceps muscles in patients with substantial established elbow flexor contractures.[22] The surgical release improved pain relief, passive range of motion (ROM), and decreased spasticity in patients with elbow flexion deformity after upper motor neuron injury.

Knowledge Gaps and Future Research

- There are no trialed interventions for preventing skin breakdown among persons with stroke.
- There is no rehab-specific evidence for skin breakdown prevention.
- Best use of splints to prevent and manage contractures; higher-quality intervention and observational work is needed.
- Long-term stretching programs may hold promise and are low-cost, but few trials have tested programs longer than 12 weeks.

3.2. Venous Thromboembolism Prevention

Recommendations for Venous Thromboembolism Prevention
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-R	1. In persons with acute stroke who have moderate to severe mobility limitations, intermittent pneumatic compression (IPC) is recommended to reduce the risk of venous thromboembolism (VTE).[1–3]
3: Harm	B-R	2. In persons with stroke, use of elastic compression stockings is not effective for the prevention of VTE.[4,5]
2b	A	3. In persons with acute ischemic stroke who are hospitalized and have limited mobility, the benefit of prophylactic-dose subcutaneous heparin (unfractionated heparin [UFH] or low-molecular-weight heparin [LMWH]) on reducing pulmonary embolism (PE), mortality, or dependent functioning is unclear given the risk of intracranial hemorrhage (ICH) and extracranial hemorrhage.[6,7]
2b	B-R	4. In persons with acute ischemic stroke who are hospitalized and have limited mobility, there is an uncertain benefit of prophylactic-dose LMWH over prophylactic-dose UFH to reduce PE, mortality, or dependent functioning given the risk of ICH and extracranial hemorrhage.[8]
2b	B-R	5. In persons with acute ICH who are hospitalized and have limited mobility, the benefit of prophylactic-dose subcutaneous heparin (UFH or LMWH) to reduce PE, mortality, or dependent functioning is unclear.[9,10]

Synopsis

VTE, which includes deep vein thrombosis (DVT) and PE, is common after stroke due to prolonged immobility and decreased activity levels. VTE prevention strategies encompass both mechanical and pharmacological treatments for persons with both ischemic and hemorrhagic stroke who have mobility limitations (ie, cannot walk to the toilet without the help of another person).[1] Prophylactic therapy initiation can depend on stroke type, with treatment typically continuing throughout rehabilitation or until mobility improves. Patients with mild motor deficits discharged directly home may not require VTE prophylaxis, while those treated in skilled nursing facilities with extended stays beyond active rehabilitation have prophylaxis duration determined at their physicians' discretion. Adverse events have been observed with both mechanical and pharmacological treatments.

Recommendation-Specific Supportive Text

1. IPC includes inflatable sleeves applied to the calf and/or thigh with intermittent muscle and vascular pressure to enhance blood flow. A systematic review and meta-analysis found that IPC for patients with acute stroke and limited mobility significantly reduced the incidence of DVT (risk ratio [RR], 0.50 [95% CI, 0.27–0.94]).[13] DVT events did not differ for continuous 24-hour versus intermittent IPC. IPC was associated with a significant trend in reduced risk of DVT (RR, 0.28 [95% CI, 0.14–0.56]) for patients with hemorrhagic stroke, but not for patients with ischemic stroke, with moderate heterogeneity. For all patients with stroke, IPC was associated with a slight increase in 6-month survival of 4.5 days (95% CI, −0.2 to 9.1), but the mean quality-adjusted survival improvement was estimated to be <1 day. A systematic review with a Bayesian network meta-analysis of patients with ICH found that IPC was associated with a significant decrease in DVT compared with controls (odds ratio [OR], 0.43 [95% credible limits, 0.23–0.80]).[2] IPC use increased adverse events (leg swelling, skin breaks; RR, 5.71 [95%

CI, 3.40–9.58]). While the length of time needed to use IPC is not clear, one study found that 3 hours per day was effective.[1] IPC should not be used in patients with open leg wounds and should be used with caution in persons with existing DVT, heart failure, severe peripheral vascular disease, or cognitive impairment for which attempts to mobilize may lead to falls.[11]

2. Elastic compression stockings apply controlled, graduated pressure to the legs, with the highest pressure at the ankle that gradually decreases toward the thigh. This promotes venous blood return from the lower extremities to the heart by compressing superficial veins and forcing blood into the deeper venous system. The compression counteracts the effects of immobility and reduced muscle pump function to help prevent blood from pooling in the lower legs. The CLOTS study, an RCT of 2518 patients with stroke, found that using elastic compression stockings was associated with a slight, nonsignificant increased hazard of death at 6 months compared with no preventative treatment (trial 1: hazard ratio [HR], 1.087 [95% CI, 0.913–1.295]; trial 2: HR, 1.037 [95% CI, 0.892–1.205]).[4] There were no statistically significant differences in VTE events and no effect on symptomatic proximal DVT or PE occurrence compared with no stockings.[15] Furthermore, patients who wore compression stockings had >4 times the risk of developing skin complications compared with those who did not wear them (RR, 4.18 [95% CI, 2.4–7.3]).[12] The skin complications may be related to the patients having underlying circulation problems (eg, peripheral vascular disease, diabetes), and the external pressure from the stockings can reduce blood flow and cause skin damage or tissue death.
3. A 2016 meta-analysis[11] and 2017 Cochrane[8] review examined the use of prophylactic anticoagulant interventions for VTE prophylaxis among patients with acute ischemic stroke, key outcomes (mortality or functional status, symptomatic pulmonary embolisms, DVTs), and adverse events. Prophylactic anticoagulants were not associated with any significant effect on mortality during the treatment period (OR, 0.95 [95% CI, 0.85–1.07], 11 RCTs,15 309 patients, high-quality evidence; OR, 1.06 [95% CI, 0.78–1.47], 8 RCTs, 3102 patients, low-quality evidence), or mortality or dependency at follow-up (OR, 1.00 [95% CI, 0.93–1.07], 6 RCTs, 15 560 patients, high-quality evidence).[8] There were statistically significant reductions in symptomatic PEs during treatment (OR, 0.69 [95% CI, 0.49–0.98]; 10 RCTs, 15 823 patients, moderate-quality evidence) and in DVTs (OR, 0.21 [95% CI, 0.15–0.29], 9 RCTs, 785 patients, low-quality evidence), most of which were asymptomatic.[11] Prophylactic anticoagulant use was statistically significantly associated with increases in symptomatic ICH (OR, 1.68 [95% CI, 1.11–2.55], 9 RCTs, 15 688 patients, moderate-quality evidence) and symptomatic extracranial hemorrhages (OR, 1.65 [95% CI, 1.0–2.75], 9 RCTs, 15 827 patients, moderate-quality evidence).[11] Whiteley et al were unable to define a targeted approach to identify patients who would benefit from early anticoagulant therapy.[7]
4. A 2016 meta-analysis and a 2017 Cochrane[8] review compared LMWH or heparinoid versus UFH for venous VTE prophylaxis among patients with ischemic stroke for key outcomes and adverse events. LMWH/heparinoids, compared with UFH, had no significant effect on death during treatment (7 RCTs, 3012 patients, moderate-quality evidence) or on dependency at follow-up (1 RCT, 1746 patients, moderate-quality evidence).[11] The use of a LMWH/heparinoid was associated with a statistically significant reduction in DVTs, which were mostly asymptomatic (OR, 0.55 [95% CI, 0.44–0.70], 7 RCTs, 2585 patients, high-quality evidence).[8] For adverse events, there was no significant reduction in symptomatic intracranial hemorrhage, but LMWH or a heparinoid was associated with a greater risk of major extracranial hemorrhages (OR, 3.79 [95% CI, 1.30–11.03], 7 RCTs, 3012 patients, moderate-quality evidence). LMWH is more convenient for nurses and patients because it can be administered once per day. Higher cost and increased bleeding risk in older patients with renal impairment are disadvantages of LMWH.
5. A 2020 systematic review and meta-analysis[2] did not find evidence of statistically significant differences between pharmacological thromboprophylaxis and control for VTE (OR, 0.93 [95% credible limits, 0.19–4.37]) for patients with ICH. Data from the 2021 PREVENTIHS study, which was prematurely stopped after the randomization of 73 patients, due to the low recruitment rate, were meta-analyzed with results from other studies.[10] Results showed that anticoagulants were associated with a nonsignificant reduction in any VTE (OR, 0.81 [95% CI, 0.43–1.51]), PE (OR, 0.53 [95% CI, 0.17–1.60]), and mortality (OR, 0.85 [95% CI, 0.64–1.12]), without increase in hematoma enlargement (OR, 0.97 [95% CI, 0.31–3.04]).[10] For patients with ICH, a 2023 Cochrane review[9] reported that starting short-term prophylactic dose anticoagulation was not significantly associated with mortality (RR, 1.00 [95% CI, 0.59–1.70], 3 RCTs; very low-certainty evidence), VTE (RR, 0.84 [95% CI, 0.51–1.37], 4 RCTs, very low-certainty evidence), ICH (RR, 0.24 [95% CI, 0.04–1.38], 2

RCTs, very low-certainty evidence), or independent functional status (RR, 2.03 [95% CI, 0.78–5.25], 1 RCT, very low-certainty evidence) at 90 days. No RCT reported on adverse events.

Knowledge Gaps and Future Research

- Fundamental research is needed to identify mechanisms that cause unprovoked VTE in patients, distinguish hemostasis from thrombosis pathways, and determine what may constitute preventable VTE.
- Clinical research is needed to develop personalized diagnostic, treatment, and prevention methods tailored to individual patients. This may include evaluating the use of electronic medical record data to automatically provide risk assessment, suggesting an appropriate level of VTE prophylaxis, as well as comparing VTE risk scoring prospectively against specific pharmacological and mechanical prophylaxis.
- Studies could evaluate and test the best methods to prevent missed prophylaxis dosing and improve compliance, and then create evidence-based tools to address overuse and underuse patterns.
- Large cohort studies could examine biological and environmental VTE risk factors and quantify surveillance bias on VTE rates, as well as study indications and triggers for VTE diagnostic studies.
- From a population health perspective, research could evaluate public awareness campaign effectiveness, such as the best methods to disseminate VTE risk assessment and prophylaxis education to practitioners, as well as patients and families.
- An area of emerging research focuses on the role of genetic factors and biomarkers in VTE risk.
- Additional research is needed on new approaches for preventing VTEs among patients with intra- and extracranial hemorrhage.
- Additional research is needed on the role of VTE prevention in patients with stroke who also have other prothrombotic conditions, such as cancer, or during pregnancy.

3.3. Treatment of Bladder and Bowel Dysfunction

Recommendations for the Treatment of Bladder and Bowel Dysfunction
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
Bladder Dysfunction		
1	B-NR	1. In persons with stroke, assessment of the patient's premorbid urological issues is recommended to develop a bladder care plan.[1,2]
1	B-NR	2. In persons with poststroke urinary incontinence or retention, assessment of urinary retention through volumetric bladder scanning or postvoid catheterization is recommended to develop a bladder care plan.[1,2]
1	B-NR	3. In persons with stroke admitted to postacute care rehabilitation with an indwelling catheter, removal of any urinary catheter within 24 hours after placement is recommended to improve urinary outcomes.[3,4]
2a	B-NR	4. In persons with stroke, assessment of cognitive awareness of the need to void or of having voided is reasonable to develop a bladder care plan.[1,2]
2b	B-R	5. In persons with stroke with urinary incontinence, timed prompted voiding might be reasonable to reduce urinary incontinence.[1,2,5–7]
2b	B-R	6. In persons with chronic stroke with urinary incontinence, pelvic floor muscle training (PFMT) might be reasonable to reduce urinary incontinence.[1,5,7–12]
2b	B-R	7. In persons with stroke with urinary incontinence, noninvasive electrical stimulation might be reasonable to reduce urinary incontinence.[1,7,10,13,14]
Bowel Dysfunction		
2b	B-NR	8. In persons with stroke, assessment of premorbid bowel functioning might be reasonable to establish a bowel management care plan.[15,16]

Synopsis

Bladder dysfunction following a stroke can include urinary retention, urgency, frequency, nocturia, and incontinence. The most common issue is urinary incontinence, which is estimated to affect between 32% to 79% of persons with stroke during their acute care hospital admission,[17,18] reducing to 25% by hospital discharge, and 16% at 1 year poststroke.[1] The type and severity of urinary symptoms are thought to depend on the anatomical site of the neurological lesion.[1]

Bowel dysfunction poststroke can include constipation and bowel incontinence. Constipation is common immediately after stroke, with a prevalence of 40% in the acute phase, reducing to approximately 20% by rehabilitation discharge.[15,16]

Comprehensive management of bladder and bowel dysfunction is an essential part of the rehabilitation process because dysfunction is associated with medical complications; for example, incontinence increases the risk of skin breakdown. Furthermore, bladder and bowel dysfunction significantly affects a person's quality of life because these functions are fundamental to dignity, social participation, and successful community reintegration.[17,18] Persons with stroke have also expressed concerns about how urinary incontinence adversely affects their caregivers.[17]

Recommendation-Specific Supportive Text

1. A comprehensive assessment of bladder function is essential for developing an effective care plan that addresses the underlying causes of any dysfunction. The assessment should include a detailed history of preexisting and current urinary symptoms, comorbidities, and medications. In developing a bladder care plan, a clinical assessment can help characterize the type and severity of dysfunction by documenting voiding and storage problems, including frequency, voided volumes, and incontinence patterns (stress, urgency, or mixed), which can help identify underlying mechanisms. Several pathophysiological mechanisms can contribute to dysfunction, including urge incontinence from disrupted neuromicturition pathways, overflow incontinence from inadequate detrusor function, functional incontinence (incontinence occurs as a result of mobility, cognitive, or communication problems, not lack of bladder control), and sphincter weakness or incoordination. Some incontinence may be transient and reversible (eg, from fecal impaction).[1,2]
2. To assess bladder dysfunction, clinicians should assess urinary retention through bladder scanning or intermittent catheterizations after a patient voids, while recording volumes with urinary incontinence or retention. A 3-day bladder diary is a valuable initial assessment tool, documenting the number of voids (spontaneous or catheterized), voided volumes, and incontinence episodes.[1,2] Urodynamic studies may be warranted to determine the specific pathophysiological mechanisms underlying bladder dysfunction and to investigate persistent incontinence. It is important to recognize that bladder pathophysiology may evolve over time, and that non-neurologic causes of urinary obstruction can also exist in patients with stroke.
3. For patients admitted to postacute care rehabilitation with an indwelling catheter, prompt removal of the catheter can reduce the risk of catheter-associated urinary tract infections.[3]
4. For patients with stroke who have urinary incontinence, assessment of patients' cognitive awareness of their need to void or having voided can help identify treatment options.[1,2]
5. The Identifying Continent OptioNs after Stroke (ICONS II) trial examined the effectiveness of using a systematic voiding program.[2] The systematic voiding program involved a comprehensive assessment, an individualized program tailored to the physical and cognitive abilities of each patient, and a weekly progress review. For patients with adequate cognitive abilities, the program included education (eg, fluid management), an individualized voiding regimen with progressive lengthening of time intervals between voids (eg, double voiding [waiting and attempting to void again]), urge suppression techniques, keeping a diary to promote self-awareness, as well as PFMT. For patients with cognitive limitations, the care plan included prompted voiding. While the trial did not meet its sample size goals due to recruitment challenges and the COVID-19 pandemic, the implementation of the systematic voiding program did lead to lower severity of urinary incontinence for patients with stroke while in the hospital.
6. The effectiveness of PFMT as a posthospital treatment for reducing urinary incontinence has been the subject of several recent literature reviews. In a 2023 systematic review including 8 articles, of which 7 were classified as good-level evidence, Özdem et al[19] found that at 12 weeks, there was no advantage based on 3-day voiding diaries, but daytime voiding did improve. A scoping review of Anklesaria et al[8] included 10 studies in which PFMT was predominantly used to manage urinary incontinence, independently or combined with other forms of treatment such as timed voiding, intermittent catheterization, acupuncture, and drug therapy, and found that it reduced the frequency of urinary leakage.
7. Recent studies have examined the use of nonimplanted electrical stimulation as a treatment to reduce urinary incontinence. A systematic review by Ali et al[7] included 14 trials with 804 participants and found electrical stimulation to be beneficial for improving the symptoms of urinary incontinence among people with stroke. A systematic review by Cruz et al[20] included 5 trials in which transcutaneous electrical nerve stimulation (TENS) commenced <3 months poststroke had a large effect on urinary continence and a medium effect when started >3 months after stroke, and meta-analysis suggested that early and frequent treatment with electrical stimulation is better than no treatment. A third systematic review by Basthlom et al[14] included 4 RCTs and 2 observational studies and concluded that there may be a positive effect of electrical stimulation on urinary incontinence after stroke. Lastly, in a Cochrane review, Thomas et al[5] found 2 trials that suggested TENS may reduce the mean number of urinary incontinence episodes. Together, these systematic reviews suggest that noninvasive electrical stimulation might be reasonable to implement to reduce urinary incontinence.
8. With regard to bowel dysfunction, Todd et al[15] conducted a systematic review focused on treatments for people with central neurological conditions but found that studies were generally of low quality. For this reason, we limit our recommendations to

assessment of prior bowel functioning, including bowel care practices, and stool consistency, frequency, and timing before stroke may be reasonable to establish a bowel management care plan.

Knowledge Gaps and Future Research

- We would benefit from a better understanding of the natural history of poststroke continence problems, including long-term follow-up studies and developing predictive models to identify which patients will recover continence.
- Another knowledge gap relates to mapping the neural pathways connecting specific brain regions to bladder and bowel control, which would allow us to distinguish true neurogenic dysfunction from secondary factors such as mobility limitations or cognitive deficits.
- Regarding effective treatments addressing urinary and fecal incontinence after stroke, the evidence base is limited. Future studies should rigorously evaluate the efficacy of behavioral interventions (scheduled toileting, pelvic floor exercises) and technology-based solutions (smart monitoring systems that detect voiding patterns, wearable sensors for early incontinence detection).
- For identified effective treatments, implementation of best practices should be studied and then incorporated into clinical practice guidelines specific to poststroke continence management. This may include identifying barriers that prevent patients from seeking help and improving patient-provider communication about these sensitive topics, as well as the psychological and social dimensions of poststroke continence problems, and training for professional and family caregiver considerations.
- Because many persons with stroke are older adults and may be on multiple medications, the role of medication interactions and their impact on bladder and bowel dysfunction is another knowledge gap worthy of study.[21,22]

3.4. Assessment, Prevention, and Treatment of Hemiplegic Shoulder Pain

Recommendations for Assessment, Prevention, and Treatment of Hemiplegic Shoulder Pain
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-NR	1. In persons with stroke, a clinical assessment of the shoulder region to determine the presence of shoulder subluxation, spasticity, ROM restrictions, and regional sensory changes, and an assessment to determine the presence of spatial neglect is recommended to guide treatment planning focused on the prevention of shoulder pain.[1–4]

Recommendations for Assessment, Prevention, and Treatment of Hemiplegic Shoulder Pain (Continued)

COR	LOE	Recommendations
1	B-NR	2. In persons with stroke, providing patient and caregiver education (ie, ROM, positioning) for hemiplegic shoulder care, particularly before discharge or transitions in care, is recommended to increase confidence with shoulder care and to prevent shoulder injury.[5,6]
2a	B-R	3. In persons with shoulder subluxation after stroke, it is reasonable to consider using positioning devices and slings to provide support to the shoulder to prevent worsening of subluxation.[7–10]
2a	B-R	4. In persons with spastic shoulder muscles after stroke, botulinum toxin (BT) injection can be useful to decrease hemiplegic shoulder pain (HSP).[11–14]
2a	B-R	5. In persons with HSP after stroke who have clinical signs and symptoms of neuropathic pain manifested as sensory changes in the shoulder region, allodynia, or hyperpathia, a trial of neuromodulating treatments, such as peripheral nerve stimulation (PNS), is reasonable to reduce pain.[15–18]
2a	B-R	6. In persons with HSP after stroke, corticosteroid injections, suprascapular nerve block (SSNB), high-intensity laser therapy (HILT), extracorporeal shock wave therapy (ESWT), neuromuscular electrical stimulation (NMES), Kinesio taping, and acupuncture can be useful as adjuncts to standard rehabilitation, to reduce shoulder pain and improve upper extremity ROM.[11,12,19–30]
3: Harm	C-EO	7. In persons with stroke who have glenohumeral joint subluxation, shoulder weakness, or shoulder pain, the use of overhead pulley exercises is not recommended to increase ROM or reduce shoulder pain.

Synopsis

HSP is a common consequence of poststroke hemiplegia, with studies reporting incidence rates ranging from 10% to 22% and prevalence rates ranging from 22% to 47%.[1] The etiology of HSP is multifactorial, and it is recognized to have both musculoskeletal and neuropathic components.[17,31] Common factors contributing to the development of HSP include motor and sensory impairments, spasticity, glenohumeral joint subluxation, and soft-tissue injuries (eg, rotator cuff tears, biceps/supraspinatus tendonitis).[1–4] A thorough assessment to identify common risk factors is an important first step in providing poststroke shoulder care.

HSP can interfere with participation in rehabilitation, performance of daily activities, and overall quality of life.[1,4] Intervention strategies to prevent the onset of and to treat the presence of HSP are critical components of poststroke rehabilitation. Persons with stroke and their caregivers can be educated to properly position the hemiplegic shoulder and perform gentle ROM exercises to prevent shoulder injury and the development of HSP.[5,6] Positioning devices such as slings (especially during ambulation) and wheelchair arm supports (ie, lap trays and arm troughs) may be useful in reducing subluxation and shoulder pain.[7–10] Additionally, studies suggest there are a variety of adjunctive interventions that can be useful in reducing HSP.[11–30]

Recommendation-Specific Supportive Text

1. HSP requires a comprehensive evaluation that includes a detailed history and musculoskeletal and neurological examinations.[32] A meta-analysis that included 18 studies found that the most significant predictors of HSP were age, female sex, increased muscle tone, sensory impairments, left side hemiparesis, spatial neglect, positive past-medical history, and poor NIHSS score.[1] A systematic review of 21 studies found that common risk factors for HSP were: poor motor function, glenohumeral joint subluxation, and reduced range of movement at the shoulder.[4] In a large prospective observational study that spanned 1 year, 119 individuals were identified with poststroke shoulder pain. Those with more severe muscle strength impairments (manual muscle test scores between 0–1) were found to have an earlier onset of poststroke shoulder pain as compared with those with manual muscle test scores between 4 and 5.[2] Wu et al (2025) investigated predictive variables for HSP using various machine learning algorithms (ie, logistic regression, support vector machine, and random forest). Results confirmed that the random forest model performed the best, and that HSP predictive variables from high to low included multiple injuries, passive shoulder joint flexion, biceps tendon effusion, sensory disorder, supraspinatus tendinopathy, subluxation, diabetes, and age.[3] The identified risk factors in these studies can be used to guide assessment.
2. Educating persons with stroke and caregivers on proper care of the hemiplegic shoulder may be an important strategy in preventing the development of shoulder injury.[33] A prospective cohort study involving persons with subacute stroke found that the addition of an education program to standard care significantly improved motor recovery and decreased the frequency of shoulder injury at discharge compared with standard care alone. However, there were no significant differences in pain.[5] The educational program was provided to both patients and their caregivers in the form of 3 15-minute videos that reviewed proper shoulder positioning; subluxation prevention while sitting, standing, or during ambulation; proper shoulder ROM exercises; and transferring techniques. They were also encouraged to complete ROM exercises twice daily for the duration of the hospital stay.[5] In a small RCT involving patients with acute stroke and their caregivers, adding 3 individual educational sessions focused on shoulder care resulted in no significant group differences in pain reduction either postintervention or at follow-up. However, the number of survivors reporting "no pain" at follow-up increased by 29% in the experimental group, but decreased by 6% in the control group. Caregivers' feedback scores were higher in the experimental group, suggesting they felt more confident in providing shoulder care.[6]
3. Shoulder subluxation can cause stretching of soft-tissue structures and is a risk factor for the development of shoulder pain.[3,4,33] Several studies suggest that positioning devices such as slings[7–9] and wheelchair arm supports[10] may reduce traction on the joint and reduce pain. A systematic review including 8 studies found that using a shoulder orthosis immediately reduced vertical subluxation on x-ray, but this was not maintained without the orthosis. Wearing orthoses with proximal and distal parts reduced pain in most persons with stroke when worn for 4 weeks.[9] An RCT comparing the effects of wearing a dynamic shoulder orthosis versus Bobath sling found that the horizontal distance of subluxation significantly improved in the dynamic group, with no significant differences in vertical distance or significant changes in pain.[8] An RCT comparing the use of a modified lap-tray (sitting) and a triangular sling (standing) with the use of a hemisling found no significant differences between groups in shoulder subluxation. Trends in the experimental group to develop less pain at rest and during shoulder external rotation, and less contracture of shoulder external rotation were noted.[7] Lastly, an RCT investigating the effects of adding wheelchair arm support to standard care reported that both groups had significant reductions in pain at 4 and 12 weeks; between-group differences favored the experimental group at 12 weeks.[10]
4. Increased muscle tone has been identified as a risk factor for the development of HSP.[1] BT is a neurotoxin that inhibits acetylcholine release and reduces spasticity.[13] Several systematic reviews with meta-analyses of RCTs have found that when BT is injected into the shoulder musculature, it can be an effective intervention for reducing HSP. Two meta-analyses reported significant findings in favor of BT for reducing pain at 1 and 4 weeks postintervention.[13,14] One study reported non-significant effects of BT at 12 weeks postinjection,[13] while the other reported significant findings in favor of BT.[14] Both studies reported significant findings in favor of BT for increasing shoulder ROM and upper extremity function.[13,14] Adverse effects were reported in 4 of the studies included

in the Xie et al (2021) meta-analysis, but there were no differences between groups with respect to RR.[14] Similarly, Chiu et al (2021), in a network meta-analysis, reported significant findings in favor of BT for reducing pain at 4 weeks and between 4 and 12 weeks.[11] Finally, de Sire et al (2022) reported significant findings in favor of BT on pain reduction in their network meta-analysis.[12] These meta-analyses suggest that BT can be an effective intervention for reducing HSP.

5. Poststroke shoulder pain can have both musculoskeletal and neuropathic features.[31] For individuals with neuropathic symptoms, neuromodulation interventions show promising benefits based on RCTs and meta-analyses. Qiu et al (2019) conducted a meta-analysis of 6 studies with robust methodological quality. Electrical stimulation significantly reduced pain and improved pain-free external rotation compared with control conditions, with subgroup analyses favoring TENS and PNS. Functional gains in ADLs were also significant.[16] Wilson et al (2014) performed an RCT comparing PNS to usual care, demonstrating greater pain reduction and improved shoulder function in the PNS group.[18] Long-term outcomes were supported by Wilson et al (2018), who reported sustained pain relief and functional improvements in a multicenter case series using a fully implantable PNS systems over 2 years, highlighting durability and safety.[17] Complementing these findings, Na et al (2024) retrospectively analyzed pulsed radiofrequency neuromodulation (PRF) to the suprascapular nerve in hemorrhagic patients with stroke, showing reduced pain scores and improved shoulder ROM without major adverse events.[15] Collectively, these studies indicate that electrical and neuromodulatory techniques, particularly PNS, TENS, and PRF, can be beneficial and safe for alleviating HSP and enhancing upper-limb function after stroke.
6. Studies suggest that various interventions can reduce HSP when combined with standard care. In an RCT, Hou et al (2022) found that single-site (subacromial-subdeltoid and dual-site [addition of biceps long head]) ultrasound-guided corticosteroid injections significantly reduced HSP and improved secondary outcomes at 1, 4, and 12 weeks. Between-group differences favored the dual-site group on most outcome measures at 4 and 12 weeks.[22]

   Three meta-analyses of RCTs reported the effects of SSNB on HSP. Chiu et al (2021) reported significant findings favoring SSNB at 4 weeks.[11] Wang et al (2021) reported significant findings favoring SSNB after 1 month compared with placebo. When SSNB was compared with suprascapular nerve PRF, pain relief was greater for PRF at 1 and 3 months.[27] de Sire et al (2022) reported significant findings in favor of both SSNB and PRF for reducing HSP.[12]

   Two RCTs found that HILT significantly reduces HSP when added to standard care. Dajpratham et al (2025) compared HILT with ultrasound and found significant improvements in HSP at rest and with motion in the HILT group, and with motion in the ultrasound group, with no significant group differences.[19] A combined therapeutic exercise program with HILT resulted in significant reductions in HSP and ROM improvements in persons with stroke with partial thickness rotator cuff tears.[23]

   Two RCTs and a meta-analysis provide evidence that ESWT significantly reduces HSP when added to standard care. Zhang et al (2023) found significant reductions in HSP after either ultrasound-guided corticosteroid injection or ESWT.[29] Haghighat et al (2023) compared ESWT versus sham ESWT. Both groups showed improvement in pain at 4 and 8 weeks; between-group differences favored ESWT.[21] Consistent with this, a meta-analysis of 18 RCTs found a significant reduction in HSP favoring ESWT.[30]

   One meta-analysis reported that low-frequency electrical stimulation applied to the shoulder reduced HSP and improved upper-limb function more than control conditions.[25]

   Three meta-analyses of RCTs found that Kinesio taping significantly reduces HSP and decreases shoulder subluxation when added to standard care. Conflicting evidence was found with respect to other secondary outcomes.[20,24,26]

   Lastly, results from 1 meta-analysis suggest that acupuncture with rehabilitative training is better than rehabilitative training alone in reducing HSP and improving shoulder ROM, upper-limb motor function, and ADLs.[28]
7. Due to the complexity of the shoulder joint and the biomechanics involved with overhead motions, aggressive ROM, if done improperly, could do more harm than good. Thus, the use of overhead pulley exercises after stroke should be avoided.[33]

Knowledge Gaps and Future Research

- Multiple interventions have shown effectiveness at reducing HSP. Further research should be directed at identifying optimal intervention strategies through comparative studies.
- Recent evidence suggests that repetitive transcranial magnetic stimulation (rTMS) has the potential to reduce HSP and improve upper-limb function after stroke. In a systematic review and meta-analysis of 11 studies with 584 participants, rTMS was significantly more effective in relieving pain and improving upper-limb function compared with the control group, and low-frequency rTMS was superior to high-frequency rTMS. However, the generalizability

of the results is limited, secondary to heterogeneity among included studies, small sample sizes, and lack of long-term follow-up.[34] Further research is needed to determine the benefits of rTMS.

- Robot-assisted rehabilitation also has the potential to reduce HSP by providing opportunities for repetitive passive and active assistive exercises with the weight of the limb supported. In a systematic review of the literature investigating the effects of robot-assisted therapy, 3 studies were identified for inclusion. Results were mixed with respect to the alleviation of pain, with 2 studies reporting positive effects and 1 study reporting negative effects. Further research is needed to determine the benefit of robot-assisted rehabilitation for the treatment of HSP.[35]

3.5. Central Poststroke Pain

Recommendations for Central Poststroke Pain
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	C-EO	1. In persons with pain poststroke, a diagnosis of central poststroke pain (CPSP) should be based on proposed diagnostic criteria to improve validity and consistency and to help plan treatment.
1	C-EO	2. In persons with CPSP, a choice of pharmacological treatments individualized to the person's needs, response, and any adverse effects is recommended to try to reduce pain.
2a	C-LD	3. In persons with CPSP, established measures (eg, the Numerical Rating Scale, the Visual Analog Scale, or the Faces Pain Scale) are reasonable to monitor pain and response to treatment.[1]
2a	B-R	4. In persons with CPSP, duloxetine, lamotrigine, or amitriptyline are reasonable first-line treatments to reduce pain.[2–4]
2a	C-EO	5. In persons with CPSP, multidisciplinary pain management, in conjunction with pharmacotherapy, is reasonable to improve pain and psychosocial outcomes.[5]
2b	B-NR	6. In persons with CPSP, pregabalin or gabapentin may be considered as second-line treatments to reduce pain.[6,7]

Synopsis

CPSP results from a lesion anywhere along the spinothalamic and thalamocortical tracts within the central nervous system. Proposed diagnostic criteria include requirements that the pain occur after stroke, be located in an area of the body that corresponds to the lesion in the central nervous system, and not be accounted for by nociceptive or peripheral neuropathic pain.[8] The incidence of CPSP in 2 population-based studies was 7.3% and 11%, respectively, and CPSP often, but not always, has an early onset poststroke.[9,10] Strong evidence for pharmacologic treatments is limited, with only small RCTs supporting the use of duloxetine, lamotrigine, or amitriptyline.[2–4] Weaker still is the evidence for pregabalin and gabapentin, and no reliable evidence supports carbamazepine, phenytoin, or levetiracetam.[2,6,11,12] Noninvasive neuromodulation has been investigated for the treatment of CPSP, with non-RCTs and small RCTs of transcranial direct current stimulation (tDCS) and rTMS showing mixed results.[13–18] Invasive neuromodulation for CPSP, including motor cortex stimulation and deep brain stimulation, has been studied in numerous small and mostly non-RCT studies. There have been conflicting results, but often, the conclusions are optimistic, with reviews and meta-analyses suggesting possible benefit and indicating that motor cortex stimulation may be more effective than deep brain stimulation. Given the invasive nature of the procedures and risk of significant adverse effects, these interventions are considered most applicable to severe cases, refractory to safer interventions.[19–26]

Recommendation-Specific Supportive Text

1. CPSP is a diagnosis of exclusion, and no clear single feature or combination of features defines it. Criteria first proposed by Klit et al in 2009 have been replicated, wholly or in part, in numerous subsequent studies.[4,6,8,27] It is suggested that the diagnosis be made based on history, a physical examination (with special focus on the sensory examination), and imaging of stroke lesion(s). Mandatory criteria include a history of stroke with pain that started at the time of, or after, stroke and in an appropriate anatomic distribution. Other common causes of pain poststroke (eg, spasticity, shoulder pain) should be sought and ruled out as the sole cause of pain (overlap is not uncommon). Supportive features include sensitivity to touch and temperature, "pins and needles" sensations, and others; burning pain was the most common type described.[8,10,28] A consistent set of diagnostic criteria will be very important to ensure the generalizability of future research studies.
2. Given the paucity of strong evidence supporting specific pharmacologic treatments for CPSP, a holistic approach considering all aspects of a person's conditions (eg, comorbid depression or other forms of pain) seems prudent.[5,29] Medications that might address multiple conditions may be prioritized, with sequential dose escalation trials of multiple medications (one at a time) patiently implemented. Response to treatment and adverse effects help direct the approach.
3. There is no standardized approach to the measurement of CPSP. Many generic pain scales have been reported in the setting of poststroke pain measurement, with the Numerical Rating Scale, the Visual Analog Scale, and the Faces Pain Scale being commonly used. In a systematic review of the

psychometric properties of these scales in persons poststroke, risk of bias and modest sample sizes prevented any definitive recommendations. That said, the authors supported the Face Pain Scale as the best evidence-based tool.[1]

4. The best evidence for the pharmacologic treatment of CPSP was demonstrated in small RCTs that evaluated the use of duloxetine, lamotrigine, or amitriptyline, and thus, these medications are thought best as first-line treatments. An RCT of 30 to 60 mg of duloxetine (N =82) showed significant reductions in pain on multiple scales and an 80.5% responder rate (>2-point decrease on the Numerical Rating Scale).[4] A non-RCT study in 37 patients also supported duloxetine's effectiveness.[30] An RCT with 27 patients showed significant pain reduction with lamotrigine, but only at the 200 mg/d dose, which the authors described as "moderately effective."[3] In another non-RCT in 30 patients, lamotrigine improved pain as measured by the Visual Analog Scale compared with baseline, adding lower-quality additional support to its effectiveness.[12] Despite long-standing clinical popularity, the only RCT data supporting the use of amitriptyline in CPSP are from a trial of 15 patients randomized to carbamazepine and amitriptyline. Only the amitriptyline arm achieved significant pain reductions, starting at about 2 weeks and with a goal dose of 75 mg/d.[2]
5. A variety of interventions have been studied for the treatment of CPSP. Each person presents with unique pain features, patterns of response (or nonresponse) to pharmacologic treatments, and comorbidities. As such, a comprehensive approach to treatment may include multidisciplinary pain management (physiatrists, neurologists, pain specialists, psychologists, neurosurgeons, and physical and occupational therapists) that can optimize treatment effectiveness through the personalized application of medications; psychosocial treatments such as cognitive behavioral therapy (CBT); physical therapy; and for refractory cases, judicious use of noninvasive and invasive neuromodulatory treatments.[5]
6. In perhaps the largest RCT in persons with CPSP (N=219), pregabalin at doses of 150 to 300 mg twice daily was compared with placebo and failed to show any significant effect on mean score from the last 7 available scores of the Daily Pain Rating Scale; secondary analyses significantly favored pregabalin for 2 of 8 measures.[6] A much smaller non-RCT suggested that pregabalin reduced pain compared with a baseline measure, which is only weak evidence of efficacy.[12] One non-RCT (N=84) studied gabapentin 300 mg twice daily and showed significantly reduced pain on the Numerical Rating Scale.[7] Lastly, miragabalin was studied in a non-RCT in Japan and showed significantly decreased scores on the Visual Analog Scale (this drug is not available in the United States).[31]

Knowledge Gaps and Future Research

- A widely accepted and validated definition of CPSP is needed.[8]
- Standards for pain assessment tools and definitions for "response" to CPSP treatment are needed to facilitate high-quality and comparable future research studies.[1]
- Larger, high-quality RCTs are needed for all possible CPSP treatments, including pharmacologic treatments, noninvasive neuromodulation, and invasive neuromodulation.[32]
- For all CPSP neuromodulation treatments, additional research needs to be done to optimize treatment locations, treatment dose, and treatment duration; with the optimal parameters being the focus of larger RCTs.
- High-quality research on CPSP treatment via psychologically based therapy (eg, CBT) or physical/occupational therapy is a major gap.

3.6. Prevention of Falls

Recommendations for Prevention of Falls
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-NR	1. For persons with stroke, a formal fall prevention program is recommended to decrease fall risk.[1]
2a	B-R	2. For persons with stroke, balance exercises can be beneficial to decrease falls.[2–5]
2a	B-NR	3. For persons with stroke, it is reasonable to perform an annual fall risk evaluation with a valid measurement instrument appropriate to the setting to assess if intervention is indicated.[6,7]
1	C-EO	4. For persons with stroke, it is recommended that they and their caregivers receive information targeted at home and environmental modifications designed to decrease falls.
2a	B-R	5. For persons with stroke, it is reasonable to provide tai chi training to decrease fall risk.[8,9]
2a	B-R	6. For persons with stroke, it is reasonable to provide dual-task training (motor task + cognitive task) to decrease falls.[10,11]
2b	B-R	7. For persons with stroke, it may be reasonable to use exergaming as an intervention to decrease fall risk.[12,13]

Synopsis

Falls are one of the most common complications after stroke. The prevalence of falls ranges from 36%-73% during the first 6 months after hospital discharge[14–16] and remains as high as 40% to 58% at 1 year.[17–20] Persons with stroke are also at risk of being repeat fallers and experiencing a fall-associated injury.[21] A poststroke fall often causes hip fractures, leading to further mobility restriction, posing limitations on performing ADLs.[22] In addition to the physical consequences associated with fractures and related injuries, falls have psychological and social consequences. The impairments in balance, gait, motor control, perception, and vision contribute to a heightened fear of falling in persons with stroke. Fear of falling can lead to reduced levels of physical activity and deconditioning, creating a cascade that may result in greater declines in physical activity, a decrease in ADLs, a loss of independence, fewer community interactions, social isolation, and depression.

Evaluation of risk factors is widely recognized as the first step in preventing falls, which varies across settings and circumstances. Several federal and professional associations have developed fall prevention toolkits that include risk assessment instruments and protocols (eg, the National Center of Patient Safety Falls Toolkit, the Centers for Disease Control and Prevention Stopping Elderly Accidents, Deaths and Injuries Toolkit, the Agency for Healthcare Research and Quality Preventing Falls in Hospitals—A Toolkit for Improving Quality Care, and the Agency for Healthcare Research and Quality Step-Up to Stop Falls Toolkit). Fall prevention needs to be multifactorial to include education of both the patient and their caregiver(s), as well as physical rehabilitation interventions. Interventions that may be beneficial include balance exercises, tai chi training, dual-task training, and exergaming.

Recommendation-Specific Supportive Text

1. Preventing falls in patients poststroke has resulted in various exercise-based fall prevention training programs.[23] Balance training aims to improve the ability to maintain both sitting and standing balance. By engaging in balance exercises in different postures, individuals can improve the engagement and integration of physiologic systems that contribute to balance control. Balance training is relatively straightforward and inexpensive in comparison with other rehabilitation methods that require equipment.
2. In inpatient rehabilitation, there is increased emphasis on intensive mobilization for higher functional gains. Patients are challenged to achieve a higher level of function than they had prior to admission. Therefore, falls are not uncommon. There are between 2.92 and 15.9 falls per 1000 days in inpatient rehabilitation facilities compared with the general hospital rates (2.45–3.73 per 1000 days). The inpatient rehabilitation facility also offers an ideal setting to address the multiple factors that contribute to falls, given that interdisciplinary team expertise is available on site.[24] The consequences of a fall (injury, reduced functional ability, fear of falling again) can negatively affect the rehabilitation process and outcomes, increasing length of stay and ultimately, cost of care.[25] Individuals poststroke are particularly vulnerable as they are present with paresis and potential cognitive deficits. Fall risk is influenced by these intrinsic, as well as extrinsic (obstacles) and behavioral (risk-taking behaviors) factors.[26] A fall prevention program must involve all rehabilitation disciplines and address these extrinsic and behavioral factors that can lead to a fall. Examples of strategies include removal of mobile objects near patients' beds, providing sufficient hydration and nutrition, adequate lighting, demonstrating use of the emergency call device near the bed and the bed adjustment mechanism, and agreement on a voiding plan. Communication among health care providers regarding patients' fall risk status is an essential component of a fall prevention program.
3. Given that approximately 50% of patients with stroke experience at least 1 fall in the first year poststroke, it is imperative to assess the risk of falling among persons with stroke as they progress toward a partial or full recovery and leverage the information for more effective predictive and rehabilitation strategies. A review of fall risk factors[7] identified balance and motion-related measures as the most common and significant fall risk factors. The Berg Balance Scale and Timed Up and Go Test are the most commonly used and easily administered in the clinic setting to measure balance and assess fall risk. However, there is considerable variability in cutoff values across reported studies, limiting universal interpretability.
4. Fall risk prevention strategies that are implemented in the hospital and rehabilitation setting should be formally shared with patients and their caregivers prior to discharge. Education should be provided in both verbal and written formats, and the teach-back method should be used to ensure clear understanding. Education should include not only home safety (eg, proper lighting, removal of throw rugs, removal or safe placement of extension cords, installation of handrails in the bathroom and along stairs) but also include measures to ensure safety during self-care activities such as bathing and dressing.
5. While performing tai chi, a low-impact moderate-intensity exercise that focuses on controlling the stability of movements, individuals are required to perform numerous concentric, eccentric, and isometric contractions, as well as coordinate between muscle groups while maintaining specific knee and

hip postures. Holding these postures improves lower limb strength and balance, translating to decreased fall risk. Deficits in the sensory integration system, not only the motor system, may lead to falls in persons poststroke.[27] Deficits in ankle proprioception poststroke also contribute to balance impairment. Tai chi footwork facilitates the use of ankle proprioceptors to maintain dynamic balance as limits of stability are approached. Attaining and holding various positions may enhance sensory integration, improving balance, and decreasing fall risk.

6. When dual-tasking, persons with stroke show more pronounced cognitive-motor interference (performance decrements in either mobility, cognitive, or both tasks) than healthy older adults.[28] Following stroke, a link between poor dual-task mobility and falls has been identified.[29] Falls, therefore, may not be a result of balance deficits in isolation but rather the inability to effectively allocate attention to balance in dual-task contexts.[28] The reinvestment theory suggests that the performance of automatic movement deteriorates when attention is diverted internally to control it, making movement more conscious.[30] Dual-task practice is used to divert attention toward an external source, allowing motor systems to develop more automatic and effective performance.[31] Practicing cognitive tasks together with motor training also reduces dual-task cost.[32] Dual-task practice is an important therapeutic strategy to improve motor skill control at an unconscious level that may translate into decreased fall incidence.
7. Active gaming or exergaming is a series of physical activities driven by technology; for example, a video game that requires players to be physically engaged during play. During exergaming, individuals perform tasks in a virtual environment that feels like the real world. The virtual environment generated through these games can promote neuroplasticity in various areas of the brain.[33] These virtual environment-based gaming procedures have the potential to enhance motor learning, which in turn may improve balance and decrease fall risk.[34]

Knowledge Gaps and Future Research

- Future research should focus on developing an objective stroke-specific fall risk assessment with appropriate cutoff values that, compared with currently used clinical assessments, better capture the underlying mechanisms of fall risk to improve fall prevention strategies and rehabilitative care.
- Given that balance and movement-related impairments are the most significant factors influencing falls, research into using wearable Inertial Measure Unit sensors outside of a controlled clinical environment could be useful to objectively identify specific impairments, which would then inform the design of efficacious rehabilitation interventions.[35]
- There is a need for neuromechanistic studies aimed at improving our understanding of the inter- and intralimb coordination patterns required for controlling proactive and reactive stepping in people with stroke.

3.7. Mental Health Assessment and Treatment of Poststroke Depression and Anxiety, Including Emotional and Behavioral State

Recommendations for Mental Health Assessment and Treatment of Poststroke Depression and Anxiety, Including Emotional and Behavioral State
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	A	1. In persons with stroke, early screening using a valid screening instrument for poststroke depression (PSD; from 3 days to 3 months poststroke) is recommended to identify individuals in need of further evaluation and treatment.[1–3]
1	B-NR	2. In persons with stroke, periodic screening of depression, anxiety, and other psychiatric symptoms using valid measurement instruments (at 3 and 6 months, and throughout the lifespan) should be performed to improve detection and access to treatment.[2]
1	C-LD	3. In persons with stroke who experience impaired communication, screening for depression, anxiety, and other psychiatric symptoms should be performed using a valid measurement instrument or appropriate supported communication strategies designed for this population to improve detection and access to treatment.[4]
1	C-EO	4. In persons with stroke who screen positive for possible depression, a comprehensive evaluation should be conducted by a health care professional with expertise in depression to improve mental health, functional, and quality of life–related outcomes.
1	A	5. In persons with chronic stroke and pseudobulbar affect (PBA) causing distress, the use of dextromethorphan/quinidine is recommended to reduce the frequency of episodes.[5,6]
2a	A	6. In persons with PSD, use of antidepressants can be beneficial to reduce depressive symptoms.[7–12]
2a	B-R	7. In persons with poststroke anxiety, selective serotonin reuptake inhibitors (SSRIs) can be useful to reduce anxiety symptoms.[10,12,13]
2a	B-R	8. In persons with PSD or anxiety, CBT can be beneficial to reduce poststroke depressive and/or anxiety symptoms.[14–18]
2a	B-R	9. In persons with PSD, psychoeducation about the effects of stroke on mental health, dyadic and family-oriented approaches, and peer support can be useful treatment components to reduce PSD.[19–23]

Recommendations for Mental Health Assessment and Treatment of Poststroke Depression and Anxiety, Including Emotional and Behavioral State (Continued)

COR	LOE	Recommendations
2a	A	10. In persons with PSD, an exercise program at least 3 times per week can be beneficial for reducing depressive symptoms.[24,25]
2b	B-R	11. For persons with PSD, use of rTMS may be considered to reduce depressive symptoms.[7,26,27]
2b	B-R	12. In persons with PSD, combining pharmacological and nonpharmacological treatments may be considered to reduce depressive symptoms.[7,18]
2b	B-R	13. In persons with PSD or anxiety, acceptance and commitment therapy (ACT) may be considered to reduce depressive and/or anxiety symptoms.[17,28–30]
2b	B-R	14. In persons with PSD or anxiety, the use of music therapy, acupuncture, and mindfulness-based interventions may be considered to reduce depressive and/or anxiety symptoms.[17,31–33]
3-No Benefit	A	15. In persons with stroke, prophylactic use of antidepressants is not recommended for routine prevention of PSD.[8–11,34–36]
3-Harm	B-NR	16. In persons with poststroke anxiety, regular use of benzodiazepines is potentially harmful due to increased risk of impaired cognition, falls, and mortality.[37,38]

Synopsis

Mental health conditions, including PSD and poststroke anxiety (PSA), are common, affecting nearly one-third (PSD) and one-fourth (PSA) of persons with stroke.[39–41] Though prevalence estimates vary considerably depending on assessment method and timing, this far exceeds rates of depression and anxiety disorders in the general population (8.3%[42] and 2.7%,[43] respectively).

Poststroke mental health issues are likely the result of a complex dynamic interaction between biological, psychological, and social factors that change over time and occur on a spectrum, from normal responses to a life-altering event to pathological conditions that impair daily functioning. While diagnostic criteria mirror those for non–stroke-related depressive and anxiety disorders, PSD and PSA are characterized by distinct mechanisms, symptom patterns, and treatment responsiveness, warranting specific considerations. The detrimental effects of mental health issues are well-documented and include reduced independence, social engagement, therapy participation, adherence to medication, and quality of life. PSD is also associated with increased risk for stroke recurrence and mortality.[44–48] Since publication of the 2016 AHA/ASA Guidelines for Adult Stroke Rehabilitation and Recovery[49] and the 2016 AHA/ASA Scientific Statement for Healthcare Professionals on Post-Stroke Depression,[40] poststroke mental health conditions (particularly PSD) have received more attention but remain under-recognized and undertreated.

Recommendation-Specific Supportive Text

1. Most cases (71%) of PSD occur within the first 3 months poststroke.[50] Early detection and treatment of PSD is critical to achieving better outcomes poststroke. A recent meta-analysis of 6 studies (with low risk of bias) demonstrated beneficial effects of early screening as compared with no early screening on functional recovery, quality of life, and 5-year mortality rates.[1]

   Despite the 2016 guidelines recommendation to routinely screen for PSD, early screening rates remain low. Standardized, systematic implementation of a PSD screening tool can effectively increase screening rates as well as promote physician-patient dialogue about mood concerns to guide clinical decision-making of PSD management.[2,3] Selecting a psychometrically sound, validated screening tool that is also simple to implement is essential (Table 3).
2. Although the highest rates of PSD occur early on, mental health concerns may surface and/or persist long after a stroke[50,51] and should be continually monitored and appropriately managed. Importantly, persons with stroke have a 73% greater risk of attempted or completed suicide,[52,53] with suicidal ideation nearly triple that of the general population (12.25% versus 4.3%) and incidence of deliberate self-harm or death by suicide at 11.1 per 10 000 (compared with 3.2 in matched controls).[54] Despite this risk, screening for suicidal thoughts remains rare. Periodic screening in outpatient settings using validated measures is recommended to improve detection of mental health concerns; providers should consider selecting a measure that includes a suicide item (eg, the Patient Health Questionnaire [9-item]; Table 3).
3. Mental health is typically assessed using self-report, which may not be appropriate or feasible to use with someone who has significantly impaired communication. Additionally, most studies systematically exclude individuals with impaired communication, limiting generalizability.[55] However, persons with stroke who experience impaired communication are at greater risk of mental health concerns than those with intact communication.[56,57] There are very limited options for PSD and PSA assessments for persons with impaired communication[4,58] (Table 3); alternatively, supportive communication strategies should be used with existing validated measures to improve detection and access to treatment.
4. Though the importance of screening for mental health concerns cannot be overstated, screening alone without subsequent treatment is insufficient. As shown in 2 recent studies using national data samples from Australia and the United States, one-half to two-thirds of patients with stroke

Table 3. Anxiety and Depression Assessments Validated for Use in Persons With Stroke

Measure	Description	Cutoff	Notes
BDI-II[82,83]	21 self-report items Proxy version available	Mild, 11–16; borderline, 17–20; moderate, 21–30; severe, 31–40; extreme, >40	May not be appropriate for persons with cognitive or communication impairments without modifications
PHQ[84,85] PHQ-2,[86] PHQ-9[84]	Self-report depression measure on the presence and/or severity of symptoms over the past 2 weeks 2-item: 2 hallmark symptoms of depression: depressed mood and anhedonia; used as a screen 9-item: severity of depressive symptoms over the previous 2 weeks	≥1 (Yes/No) ≥2 or 3 (multiple choice) ≥10 Mild, 4–9; moderate, 10–14; moderate-severe, 15–19; severe, 20+	PHQ-9 includes suicide item May not be appropriate for persons with cognitive or communication impairments without modifications
GDS[87,88]	15 or 30 items, "Yes/No" response format Does not include somatic symptoms	>11 (30-item) >5 (15-item)	Geared toward older adults; response format may be useful for persons with impaired communication
HDRS[85,89]	17-item, clinician rated depression measure May replace structured interviews based on diagnostic criteria	Mild, 8–16; moderate, 17–23; severe, 24	Screens suicide May not be appropriate for persons with cognitive or communication impairments without modifications
MADRS[88,90]	10-item, clinical interview (self-report available) Less reliant on physical symptoms	Mild, 7–19; moderate, 20–34; severe, 35–60	Assesses suicide
HADS[91,92]	14 self-report items (7 depression, 7 anxiety), rated based on severity of symptoms over the past week HADS-A is the most commonly used measure of PSA	≥8 or 11 for HADS-Total; ≥4, 5, or 7 for HADS-D; ≥5 for HADS-A	May not be appropriate for persons with cognitive or communication impairments without modifications
BOA[93]	10 self-report and carer-rated versions of observable behaviors related to anxiety	≥13/14 Mild, 7–13; moderate, 14–17; severe, 18+	Potential for use with persons unable to self-report anxiety
VAMS[94] D-VAMS[95]	Indicate mood state on a vertical line Bipolar scales used to report mood by modifying facial expression images using a slider on a tablet	Based on normative data	Developed and validated for persons with aphasia
SADQ[96]	10 items of observable behaviors related to depression	≥15	

BDI-II indicates Beck Depression Inventory-II; BOA, Behavioural Outcomes of Anxiety scale; GDS, Geriatric Depression Scale; HADS, Hospital Anxiety and Depression Scale; HDRS, Hamilton Depression Rating Scale; MADRS, Montgomery–Åsberg Depression Rating Scale; PHQ-2/PHQ-9, Patient Health Questionnaire (2-item and 9-item versions); SADQ, Stroke Aphasia Depression Questionnaire; and VAMS/D-VAMS, Visual Analog Mood Scale/Dynamic Visual Analog Mood Scales.

who screened positive for mental health concerns received no treatment within that year.[59,60] Individuals who screen positive for depression should undergo a comprehensive evaluation using a clinical diagnostic interview (the gold standard for diagnosing PSD) conducted by a health care professional with relevant expertise in diagnosing and managing depression to determine treatment strategies.[61]

5. PBA, also known as emotional lability, emotionalism, emotional incontinence, or involuntary emotional expression disorder, occurs in 11% to 37.8% of individuals following stroke[6] and is characterized by episodes of involuntary or exaggerated emotional expression, such as laughing or crying. PBA can be highly disruptive to daily life, often interfering with social interactions and the ability to work.[62] Available treatment options include dextromethorphan hydrobromide/quinidine sulfate (DM/Q), which is the only FDA-approved pharmacological treatment of PBA. Three large, double-blind, placebo-controlled trials demonstrated a significant reduction in the number of PBA episodes versus placebo,[6] though it should be noted that these trials did not include patients with stroke. An additional large, open-label 90-day effectiveness trial (PRISM-II)[5] similarly demonstrated substantial improvement in PBA clinical symptom severity and episode frequency in a patient population that more closely resembled "real-life" clinical circumstances, including stroke. Antidepressants may also be considered an option. A recent Cochrane review of pharmacological treatment of PBA included 7 RCTs (n=239) that suggested that antidepressants (particularly SSRIs) may reduce the frequency and severity of episodes of PBA when compared with placebo.[63] However, larger, more robust trials are needed to demonstrate efficacy for this off-label use of antidepressants.
6. Antidepressants remain the first line of treatment for PSD. A Cochrane review on PSD treatments found very low-certainty pooled evidence from 18 RCTs (n=1829) suggesting benefit of antidepressants in treating depression to remission and reducing depressive symptom scores on mood rating scales compared with placebo, along with evidence of limited harm.[7] No recommendation is given for any particular class of antidepressants;

selection of a specific agent should be informed by clinical considerations, adverse-effect profiles, and pharmacological characteristics. However, SSRIs are the most widely studied and typically considered first-line agents for PSD due to their minimal anticholinergic activity and low risk of clinically significant drug interactions. Four meta-analyses of RCTs have shown SSRIs to be effective in reducing depressive symptoms compared with placebo.[9,10,64,65] An individual patient meta-analysis of 3 large trials on fluoxetine (FOCUS,[66] AFFINITY,[8] EFFECTS[67]; n=5907) found no effects on the primary outcome (mRS), but demonstrated improved emotion scores on the Stroke Impact Scale in all 3 trials.[11] Primary limitations of studies include short duration, outcome measure variability, and potential bias. Additionally, depression was not a primary outcome for any of the large, robust trials.

7. Despite the high prevalence of PSA, studies on treatment options are limited. The first line of pharmacological treatment includes SSRIs. A 2017 Cochrane review included just 1 RCT of paroxetine, which demonstrated decreases in anxiety symptoms as compared with standard care.[13] A more recent meta-analysis that included 2 different RCTs demonstrated significant reductions in anxiety symptoms in participants treated with SSRIs as compared with the placebo group.[10] Buspirone is FDA-approved for anxiety and often used as an adjunct to SSRIs in nonstroke populations.[68] Although an RCT testing buspirone showed significantly greater reductions in anxiety as compared with standard care,[13] its efficacy and safety in PSA still need to be established through larger clinical trials.

8. Among psychotherapeutic interventions, CBT is the most researched. CBT aims to restructure maladaptive thoughts and behaviors to improve psychological functioning and is shown to be as efficacious as antidepressants in the general population.[69] Although earlier studies' findings on CBT for PSD were mixed, mounting evidence supports its benefits for PSD and PSA. Two separate meta-analyses (n=1972;[18] n=672[14]) demonstrated significantly greater reductions in depressive and anxiety symptoms in participants receiving CBT as compared with an attention intervention or rehabilitation treatment control. Available evidence also suggests that individual and group therapy formats have comparable effects,[14] and that remotely administered CBT may be as effective as in-person.[15] While these findings are promising, more robust trials with larger samples, standardized protocols, and longer follow-up periods are needed. Moreover, although modifications may be made, CBT has not been adequately tested in persons who have significant stroke-related cognitive or communication impairments, and clinical judgment should be used to determine the appropriateness of this approach.[17,28,29]

9. Accurate, timely education about stroke, including its mental health effects, is a recommended key component of standard care. However, passive information delivery alone may worsen depression and anxiety in persons poststroke.[70] Psychoeducation, which provides patients and families with mental health information, treatment options, and coping skills, improves outcomes by enhancing treatment adherence, reducing stigma, and helping family members better understand and support patient needs.[71]

   A series of systematic reviews[19,72,73] espouse the benefits of dyadic approaches, which engage persons with stroke and their caregivers, in the treatment of anxiety and depression. Interventions that consist of 5 to 9 sessions and include psychoeducation and skill-building components are most effective. Meta-analyses[20,23] of RCTs further suggest that dyadic psychosocial approaches are better than usual care at reducing depressive and anxiety symptoms in persons post-stroke. Overall, the number of small, feasibility trials has grown substantially in this area, but well-powered RCTs are still needed to confirm the efficacy of dyadic interventions.

   Peer support may offer another effective approach. A meta-analysis of 11 trials showed potential mental health benefits, though the quality of evidence was low.[22] A recent RCT found that a community-based peer intervention led to significantly greater reductions in depressive and anxiety symptoms compared with an attention control.[21]

10. Exercise is effective in treating depression in the general population, comparable to psychotherapy and pharmacotherapy.[74] Previous stroke rehabilitation guideline recommendations[49] included considering a 4-week exercise program as a complementary treatment for PSD. Evidence from the past decade continues to support the benefit of exercise on depressive symptoms poststroke and provides further guidance on types of exercise programming that may be most effective. Two recent meta-analyses of 24 RCTs (n=1757)[24,25] found that exercise significantly alleviated poststroke depressive symptoms compared with the control group. Subgroup analyses suggested that only multicomponent training, which integrates various forms of exercise, including aerobic exercise, resistance exercise, and balance training, significantly reduced symptoms. Additionally, the greatest benefit was demonstrated in interventions lasting at least 12 weeks and consisting of more frequent (≥3 times per week) and shorter (<60 minutes) sessions,[25] or those compliant with American College of Sports

Medicine guidelines.[24] This aligns with poststroke exercise recommendations[75] and suggests that adherence to standardized exercise recommendations can lead to more substantial improvements in mental health outcomes for persons poststroke.

11. Noninvasive brain stimulation has received much attention for its potential to treat depression.[76] These interventions use magnetic pulses or electrical currents to target and modulate brain activity, often in patients whose depression has not responded to other treatments. rTMS has the most robust evidence and is FDA-approved for the treatment of depression.[76] In recent years, numerous RCTs have also examined the efficacy of rTMS for treating PSD. A Cochrane review found very low-certainty pooled evidence based on 8 included trials, suggesting rTMS has little to no effect in treating depression to remission but may reduce depressive symptom scores.[7] A network meta-analysis of 12 RCTs similarly found significant improvements in depressive symptoms in patients receiving rTMS as compared with sham controls or conventional treatment and further identified rTMS on the dorsolateral prefrontal cortex as producing better therapeutic effects.[27] Despite these promising findings, it should be noted that existing trials are limited by small sample sizes, short treatment and follow-up (if any) duration, and risk of bias. Therefore, higher-quality, large-sample RCTs are needed for more definitive recommendations on the use of rTMS for PSD.
12. Whereas the literature on individual treatments has been growing, relatively few studies have examined the effect of combining pharmacological and nonpharmacological treatments to reduce PSD. A Cochrane review of pharmacological, nonpharmacological, and combination treatment only identified 3 RCTs (n=278; very low-certainty evidence) that showed a beneficial effect for combination therapy (pharmaceutical intervention and psychological therapy) compared with pharmaceutical intervention alone for reducing depressive symptoms.[7] A meta-analysis specifically evaluating RCTs of CBT showed a significantly greater reduction in depressive symptoms for CBT plus antidepressants compared with antidepressants alone.[18] Though limited by significant heterogeneity and low quality across the majority of the studies, these findings are consistent with broader depression research showing that combined pharmacological and psychotherapeutic treatments are more effective than either treatment alone.[77]
13. Although studies on psychotherapeutic interventions for PSD and PSA other than CBT are limited, a growing body of research supports the use of ACT to reduce anxiety and depressive symptoms after stroke.[17,28–30] ACT aims to improve psychological flexibility through the acceptance of one's thoughts and feelings, without judgment, and while pursuing value-driven behavior. A small RCT (n=53) of group-based ACT versus treatment-as-usual demonstrated significant reductions in depressive symptoms, but not for anxiety.[29] Individually delivered through psychological nursing, ACT improved anxiety and depressive symptoms compared with a treatment-as-usual control (n=140).[30] A more rigorously designed multisite RCT (n=72) comparing individually delivered BrainACT (an adaptation of ACT for persons with acquired brain injury) with an active control showed no significant between-group differences, but anxiety and depressive symptoms decreased in both groups.[28]
14. Complementary and alternative approaches to treating PSD and PSA are those considered nonmainstream and used instead of or in conjunction with conventional Western medicine, respectively. Many of these treatments are deemed safe and noninvasive and may be valuable for individuals who experience adverse effects or contraindications to the use of antidepressants or have significant cognitive or communication impairment, though rigorous studies in this area are still needed. In general, research in this area is still considered to be in early stages in the United States, lacking large, robustly designed trials to test interventions. However, existing studies suggest that there may be some benefit to using these approaches in conjunction with conventional treatments.

A meta-analysis of nonpharmacological treatment approaches for PSD included 5 RCTs (n=228) on complementary and alternative treatment (specifically, acupuncture and music therapy).[32] Overall results suggested small effect sizes for nonpharmacological approaches, with individual beneficial effects on depressive symptoms for complementary and alternative treatment and psychosocial therapy. A subgroup analysis further showed a benefit of music therapy but not acupuncture. Separate meta-analyses of 20 RCTs (n=1625)[31] and 17 RCTs (n=1402)[33] showed that the addition of music therapy or acupuncture, respectively, to conventional treatment may result in greater reductions in depressive symptoms when compared with conventional treatment alone. Both meta-analyses were limited by including low-quality studies with small sample sizes, and all studies were conducted in China, potentially limiting generalizability.

Other approaches that may be considered include mindfulness-based interventions, which were shown to significantly reduce depressive symptoms in 7 RCTs (n=502).[78] Again, studies on PSA are more limited, but 2 small, well-designed RCTs[79,80] suggest that meditation and self-help autogenic relaxation, respectively, reduce depressive and anxiety symptoms compared with controls, though findings must be interpreted with caution.

15. A substantial number of trials have investigated the potential for antidepressants to prevent PSD. A meta-analysis of 3 large RCTs (FOCUS,[66] AFFINITY,[8] EFFECTS[67]; n=5907) evaluating the effects of fluoxetine on poststroke recovery found a reduced risk of new depression and fewer new prescribed antidepressants at 6 months in participants who did not have depression at baseline.[11] However, fluoxetine was associated with an increased risk of seizures, falls with injury, fractures, and hyponatremia, though the absolute risks of these events were very low. Meta-analyses evaluating SSRIs more broadly, similarly found that they had a significant effect on preventing future depression poststroke by as much as a quarter, but also showed an increased risk of seizures and bone fractures.[10,64,65] A multicenter, double-blind, randomized, placebo-controlled trial of early administration of escitalopram (EMOTION[36]) found no significant reduction in depressive symptoms. Altogether, although potentially effective in the prevention of PSD, the routine prophylactic use of antidepressants is not recommended due to concerns about polypharmacy and potential adverse effects.
16. Benzodiazepines are frequently used to treat acute anxiety due to their quick onset of action and relatively short-lasting effects. However, regular use of benzodiazepines to treat poststroke anxiety is generally discouraged due to their potentially harmful effects, including cognitive impairment and psychomotor disturbances, which significantly increase the risk of falls, fall-related injuries, and short-term mortality.[37,38] Although not specific to stroke, robust evidence also links long-term benzodiazepine use to dependence in older adults.[81] Moreover, age-related changes in drug metabolism, the common presence of polypharmacy, and multiple comorbidities further heighten vulnerability to adverse effects in this population. Although benzodiazepine initiation among persons with stroke has declined overall, recent analysis of US Medicare claims data reveals a concerning trend: many patients receive prescriptions of benzodiazepines within 90 days of discharge, often with supplies lasting 2 weeks or longer. Evidence shows that prescriptions exceeding a 2-week duration significantly increase the risk of adverse effects, including delirium, cognitive impairment, falls, addiction, and withdrawal symptoms.[37]

Knowledge Gaps and Future Research

- There is no gold standard for assessing PSD or anxiety. Variability in assessment tools contributes to inconsistent prevalence estimates and treatment outcomes and makes cross-study comparisons challenging.
- Research on poststroke anxiety and post-traumatic stress disorder treatments is largely lacking, despite high prevalence.
- Studies including individuals with cognitive and/or communication challenges poststroke are lacking. This complicates effective screening and treatment for these individuals who are at high risk for PSD and anxiety.
- Dosing studies on behavioral interventions for poststroke mood disorders are needed.

3.8. Poststroke Osteoporosis

Recommendations for Poststroke Osteoporosis
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
2a	B-NR	1. In persons with ischemic stroke, assessment using the Fracture Risk after Ischemic Stroke Score (FRAC-Stroke) can be useful to predict fracture risk.[1,2]
2a	B-NR	2. In persons with stroke, increasing physical activity (aerobic, resistance training, and balance training) can be useful for improving bone mineral density (BMD) and reducing the risk of fractures.[3–5]

Synopsis

BMD changes occur poststroke. The BMD changes are likely multifactorial due to reduced weight bearing through the hemiplegic limb.[6] BMD changes are also seen to a lesser degree on the nonhemiplegic limb.[6,7] Furthermore, individuals who are completely immobile or bedbound may have the highest degree of changes to BMD, showing a significant reduction of BMD at the femoral neck in female individuals after 2 months of immobilization.[8]

Other factors that may contribute to reduced BMD poststroke include reduced sunlight, and thus vitamin D exposure, as well as dietary changes. Oxidative stress associated with the stroke itself also plays a role.[9] The BMD changes are coupled with an increased risk of falls due to hemiplegia, or sensory or cognitive impairment, leading to an increased risk of fracture.[10,11] A systematic review and meta-analysis found a 2-fold increase in fracture in those with stroke versus those without,[12] and almost 6% of individuals will have a fracture within their first year poststroke.[13] Additionally, individuals who sustain a fracture poststroke have higher rates of mortality and reduced quality of life compared with those who do not have a fracture.[13]

Recommendation-Specific Supportive Text

1. There are no specific poststroke screening guidelines for when or whom to screen.[14] The

Fracture Risk Assessment Tool[15] does not take stroke into consideration when stratifying fracture risk; however, other tools, such as FRAC-Stroke, have been developed to identify risk in this population.[1,2]

2. Various nonpharmacologic and pharmacologic methods are used to treat osteoporosis in the general population, though few have been studied specifically in the poststroke population. Physical activity was associated with a lower risk of fracture and improved BMD poststroke.[3–5,16,17] This includes aerobic, resistance, or balance exercises.[3–5,18–24]

Knowledge Gaps and Future Research

- The FRAC-Stroke score to identify fracture risk poststroke has been developed for individuals with ischemic stroke. Future work could validate whether this tool is also useful for individuals post–hemorrhagic stroke.
- Several lifestyle factors have been posited to improve bone health in the general population. One retrospective observational study found that individuals who stopped smoking poststroke had lower rates of fracture than those who continued to smoke.[25] Another retrospective study based on self-report showed that increased dietary protein and fiber intake may also improve BMD, especially on the hemiplegic side; however, correlations were very small.[26] Further research is indicated to explore these and other lifestyle factors that could improve BMD and reduce fractures.
- Certain therapies, including neuromuscular facilitation techniques, may improve BMD.[27] However, the study in this area had significant limitations, including extensive exclusion criteria, a combination of animal and human models, and differing intervention intensities among control and exposure groups, limiting the ability to provide a specific recommendation for these techniques. Future research could be considered in this area.
- Certain medications, such as proton pump inhibitors,[28] SSRIs,[29] and warfarin,[30] may be associated with an increased risk of fracture in the general population and are commonly used poststroke. Future research using large observational studies may help identify these and other risk factors associated with fracture poststroke.
- There is minimal evidence about the safety and efficacy of bisphosphonates[31,32] and other osteoporosis medications such as zoledronic acid[33] or romosozumab[34,35] poststroke. More large-scale studies would be beneficial in this area. Future research is warranted into the efficacy and safety of these medications, specifically in the poststroke population.

3.9. Sleep and Poststroke Fatigue

Recommendations for Sleep and Poststroke Fatigue
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
2a	B-R	1. In persons with stroke, CBT can be beneficial in improving fatigue and sleep quality.[1–4]
2b	C-LD	2. In persons with poststroke fatigue, light therapy, compared with conventional lighting, may be considered to reduce fatigue.[5–7]
3: No Benefit	B-R	3. In persons with stroke, fluoxetine is not recommended to treat poststroke fatigue.[8–12]

Synopsis

Persons with stroke have higher rates of sleep disorders[13] and a prevalence of poor sleep quality[14] than what is observed in the general population. This is relevant for recovery poststroke because sleep disorders and short sleep duration increase the risk of PSD, and sleep disorders increase the risk of CVD mortality.[15] Poststroke fatigue has been defined as a "feeling of exhaustion, weariness, or lack of energy that can be overwhelming, and which can involve physical, emotional, cognitive, and perceptual contributors, which is not relieved by rest and affects a person's daily life," and is observed in >40% of poststroke patients.[16] This condition is inversely correlated with health-related quality of life and ADLs.[17] Unfortunately, most research evaluates sleep disorders, sleep quality, and post-stroke fatigue as secondary outcomes, and methods of assessment vary among studies. Moreover, sleep is a multidimensional construct that goes beyond the absence of sleep disorders and encompasses metrics such as duration, timing, regularity and variability, architecture, alertness, and vigilance.[18] This can be assessed in the clinic from a simple question: How is your sleep?[18] Similarly, the included patient population varies between studies, mostly in terms of length of time since event. Given these limitations, few treatment options can be strongly recommended for the management of sleep and fatigue poststroke. For poststroke fatigue, fluoxetine has not been shown to produce benefits,[19] but light therapy[6,7] may be considered. To improve sleep quality in patients with sleep difficulties or fatigue, CBT may be a reasonable approach to undertake.[20]

For information on sleep apnea, please see the 2021 Guideline for the Prevention of Stroke in Patients With Stroke and Transient Ischemic Attack: A Guideline From the American Heart Association/American Stroke Association.[21]

Recommendation-Specific Supportive Text

1. CBT for insomnia is the recommended treatment for chronic insomnia, regardless of cause.[22] For patients with chronic stroke who are interested in

improving their sleep, a 6-week session of weekly digital CBT reduced sleep onset latency compared with the control approach (online daily sleep diary).[1] In patients with a history of stroke and significant fatigue (Fatigue Severity Scale score ≥4) or poor sleep (Pittsburgh Sleep Quality Index score >5), 8 weekly sessions of CBT, compared with standard of care, improved scores on the Fatigue Severity Scale, with a large effect size at the end point and at 2 months follow-up.[2] In 2 other studies that enrolled patients with a history of stroke and traumatic brain injury, CBT for weeks improved sleep quality[4,23] and Insomnia Severity Index score[4] at the endpoint, but not at 2 months follow-up compared with health education. Finally, 1 study noted a trend for sustained improvement in sleep quality in patients with acute brain injury (stroke or traumatic brain injury) receiving CBT compared with a waitlist control at 3 months follow-up during a 4-session, 6-week intervention.[3]

2. Light therapy has been evaluated for the management of poststroke fatigue using various lighting schemes. Connolly and colleagues provided a complete lighting schedule that differed in wavelength and intensity during the daytime and for 3 hours before bedtime to the active group, and a lighting schedule with no change in color temperature or intensity to the sham group.[5] The study was a randomized crossover trial performed in-home with patients with acute brain injury (21% had stroke, on average, 9 years prior). There was no impact of lighting schedule on fatigue, but the Insomnia Severity Index and sleep quality improved. Two other studies were performed in a clinical setting.[6,7] One quasi-RCT found an improvement in the Multidimensional Fatigue Inventory general fatigue subscale but not in global score, and there was no impact on sleep quality and sleepiness in patients placed under a natural lighting schedule versus standard indoor lighting for the full length of stay (average 45 days for the intervention group; 34 days for the control group).[7] The other trial provided 25 minutes of blue or red light exposure at a distance of 70 cm from the patient between 8:00 and 8:30 AM for at least 5 days (average, ≈10 days).[6] Ratings of fatigue on a visual analog scale and of sleepiness on the Karolinska Sleepiness Scale decreased to a greater extent in the group administered blue light.
3. A randomized, double-blind, placebo-controlled trial conducted in 43 stroke units in Australia, New Zealand, and Vietnam found no difference in the vitality subscale of the 36-Item Short Form Survey after 6 months of treatment with fluoxetine compared with placebo, or at 12 months follow-up, in adults diagnosed with acute stroke (2–15 days) and mRS score ≥1.[9] Similarly, outcomes of the Efficacy oF Fluoxetine – a randomisED Controlled Trial in Stroke (EFFECTS) trial, performed in 35 hospital stroke units in Sweden,[11] and the FOCUS trial, performed in 103 hospitals in the United Kingdom, showed no effect of fluoxetine on secondary outcomes of fatigue (vitality subscale of the 36-Item Short Form Survey) and health-related quality of life relative to placebo treatment for 6 months at the end point and 12-month follow-up in patients with acute stroke.[24] A Cochrane review concluded no effect of fluoxetine on poststroke fatigue and suggested that the observation likely extended to other SSRIs.[3]

Knowledge Gaps and Future Research

- Future studies are needed to test the impact of various treatment modalities, specifically for poststroke fatigue management and sleep. In most trials, fatigue is a secondary outcome, and sleep duration and quality, the only 2 factors reflected in the multidimensional nature of sleep,[25] are not evaluated. Sleep duration could be evaluated using activity monitors or, in clinical settings, from self-report assessments of sleep quality (Pittsburgh Sleep Quality Index), which would also provide information on the timing of the sleep episode. Information about sleep disorders, for example diagnosed sleep apnea, narcolepsy, restless leg syndrome, and insomnia, could be obtained from medical histories and questionnaires such as the Insomnia Severity Index[26] and the Epworth Sleepiness Scale.[24] Multiple tools are currently used to evaluate poststroke fatigue, and recommendations have been made for using the Fatigue Assessment Scale (modified or full), the Fatigue Impact Scale, and the Fatigue Severity Scale.[27,28]
- Studies evaluating the role of exercise in poststroke fatigue and sleep management are needed. Two systematic reviews including 4 studies were available,[29,30] and both presented a high risk of bias; 1 concluded no effect on fatigue, with a lack of consensus on dose (frequency, duration),[30] and the other noted no clear evidence on a best approach for promoting sleep and reducing fatigue.[29] This review suggested that exercise could be beneficial.[29] However, there was insufficient evidence from RCTs to make recommendations regarding the role of exercise interventions for sleep and fatigue management.
- Research is underway to evaluate the impact of tDCS for the management of poststroke fatigue.[31–34]
- Two small-scale RCTs with 41 participants[35] and 36 participants,[36] respectively, tested the effect

of treatment with modafinil on poststroke fatigue, compared with placebo. Results of these studies are promising but considered preliminary.
- Obstructive sleep apnea prevalence is high in patients with stroke and is often undertreated in cardiovascular practice.[37] Whether sleep and poststroke fatigue are distinct from one another and should be managed differently in patients with a sleep disorder such as obstructive sleep apnea remains to be determined.

4. ASSESSMENT

4.1. Assessment of Disability and Rehabilitation Needs

Recommendations for the Assessment of Disability and Rehabilitation Needs
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-NR	1. In persons with stroke, a formal assessment of body structures and functions, activity limitations and participation restrictions, and personal and environmental factors is recommended to inform treatment planning, care transitions, and discharge planning.[1–19]
1	B-NR	2. In persons with stroke, valid measurement instruments should be routinely administered, beginning in the acute phase and continuing through all stages of recovery and rehabilitation, to document stroke severity and disability.[4,5,7,8,11,15–17,19]
2a	B-NR	3. In persons with stroke discharged from acute and postacute care, ongoing and repeated follow-up, tailored to the individual's needs, is reasonable for at least the first year poststroke to monitor functional recovery, identify participation restrictions, and reassess rehabilitation needs.[20–23]
2b	B-NR	4. In persons with subacute stroke, computer adaptive testing (CAT) with validated assessments may be considered to assess motor function, postural control, and basic ADLs, and to improve clinical efficiency.[24,25]

Synopsis

Stroke can cause a complex array of impairments, including, but not limited to, bowel and bladder incontinence; changes in sensorimotor, cognitive, visual, perceptual, and psychosocial functions; and communication and swallowing difficulties.[1–3,6,8,9,13,18,26] These deficits often lead to activity limitations (eg, decreased ability to eat, bathe, dress, or walk) and participation restrictions (eg, working or preparing a family meal).[13,15,18] Determining disability and rehabilitation needs after stroke requires a formal assessment that targets the WHO ICF dimensions of body structures and functions, activity limitations, participation restrictions, and environmental factors (eg, social support, physical environment).[8,13,15,16,18] The stroke survivor's age, life stage, and unique needs must also be considered.[10,12–14,18,21] Given that stroke recovery evolves over time and across various settings, assessment should take place across the continuum of care, with ongoing and repeated follow-up based on the survivor's needs for at least the first year poststroke.[20–23]

A variety of global and modality-specific standardized and validated measures have been useful for documenting stroke severity, identifying disability, predicting discharge destination and long-term recovery, and monitoring progress over time.[1,2,4,5,7,8,11,15–17,19,27] CAT may be considered to assess motor function, postural control, and basic ADLs.[24,25]

Recommendation-Specific Supportive Text

1. The ICF Core Set for Stroke provides guidance for assessment across the dimensions of the ICF to identify potential problems a stroke survivor may encounter throughout the continuum of care.[13,18] Evidence suggests that various IFC Core Set for Stroke items correlate significantly with several commonly used global (ie, NIHSS, modified Barthel Index) and modality-specific (ie, Fugl-Meyer Assessment, Mini Mental State Exam [MMSE], Stroke-Specific Quality of Life) assessments.[18] The ICF Core Set for Stroke also distinguishes between the needs of persons with stroke ≤65 and >65 years of age, further promoting client-centered care.[13]

   Shorter ICF-based measures such as the 12-item WHO Disability Assessment Schedule (WHODAS) 2.0 and the 7-item WHO Minimal Generic Set correlate strongly or very strongly with conventional global measures (ie, NIHSS, mRS, and Functional Independence Measure) in patients undergoing subacute rehabilitation.[16]

   Several studies report differences between traditional measures of disability (ie, mRS) and self-perceived health, highlighting the importance of including patient-reported outcome measures to capture the full extent of disability and rehabilitation needs.[10,14] A variety of standardized and validated measures can be used alongside the ICF to assess impairments and limitations across its domains, informing treatment planning, care transitions, and discharge planning.[1–8,11,15–17,19,27]
2. Routine use of standardized assessments is essential for monitoring stroke severity, functional changes, and disability across the recovery continuum. Early evaluation establishes a clinical baseline, while repeated assessments detect progress, plateaus, or decline. The Orpington Prognostic Scale, administered within 72 hours of stroke onset, effectively identified early rehabilitation needs and predicted discharge destination from a hyperacute stroke unit.[19] Similarly, administration of the Barthel Index after acute stroke predicted

discharge destination (home versus institution-based rehabilitation)[15] and ADL dependency at 3 and 12 months, highlighting the importance of early functional assessments.[5]

Emerging research underscores the need to select appropriate tools for specific clinical goals. Wu et al found the modified Barthel Index was most effective for measuring physical activity disability, while the mRS better predicted short-term stroke severity.[17] The Dutch Stroke Score demonstrated satisfactory performance in predicting both discharge disability and 3-month outcomes, supporting its use in discharge planning.[4]

In postacute care, IRF Patient Assessment Instrument admission Section GG (self-care and mobility) scores have been shown to significantly predict discharge destination, reinforcing the value of standardized assessments in rehabilitation transitions.[7,11]Multidimensional tools such as WHODAS 2.0 and the WHO Minimal Generic Set have improved disability tracking and patient-centered goal-setting.[10] Lower WHODAS scores were associated with a higher likelihood of return to work.[8] These findings support routine use of standardized assessments to guide clinical decision-making, tailor interventions, and facilitate transitions of care across the recovery continuum.

3. Stroke recovery is a dynamic process, with rehabilitation needs evolving across time and setting. Structured, repeated assessments are essential to detect functional changes and address unmet rehabilitation needs.[20–23] One study found that 1 in 6 persons with stroke, independent in ADLs at 3 months, became dependent by 12 months, particularly older adults and women with comorbidities, leading to increased nursing home placement.[22]

   A national stroke registry of >37 000 patients found 21.5% reported unmet rehabilitation needs at 12 months.[23] These individuals were more likely to be older, ADL-dependent, institutionalized, and experiencing PSD and pain. Predictors of unmet needs included severe stroke, prior stroke, diabetes, atrial fibrillation, and female sex.[21]

   One study identified persistent unmet needs in young, chronic stroke survivors.[21] Using an assessment questionnaire, researchers found ongoing challenges in impairments, finances, and social participation, demonstrating that disability and participation restrictions often persist beyond the acute phase.[21] Another trial showed that at 3 months, 20.2% of control patients had persistent dysphagia, compared with 9.5% in the intervention group, who received standardized dysphagia assessments and therapy referrals, which led to intensified poststroke care, highlighting the importance of structured assessments following discharge.[20] These findings support long-term, individualized rehabilitation planning that adapts to evolving needs across the continuum of stroke recovery.

4. Reducing assessment burden for both persons with stroke and clinicians is an important consideration across the continuum of care. CAT is a method of assessment that can achieve validity, reliability, and efficiency by requiring the administration of items that provide the most useful information according to each stroke survivor's functional capacity.[24,25]

   The CAT–Functional Assessment of Stroke (FAS) was developed to improve the efficiency of the administration of the FAS. The FAS consists of 29 items taken from sections of the upper extremity and lower extremity Fugl-Meyer Assessment, Postural Assessment Scale for Stroke, and the Barthel Index, allowing for the evaluation of upper extremity and lower extremity motor control, postural control, and basic ADLs with 1 assessment tool.[24,25] The FAS has demonstrated sufficient Rasch reliability, validity, and responsiveness in subacute persons with stroke.[24,25]

   The CAT-FAS consists of an item bank with 58 items measuring the 4 domains of the FAS simultaneously. Administration ends when the increment of Rasch person reliability after administering an additional item is smaller than 0.010, because at this point, precision is not significantly enhanced. Evidence suggests the CAT-FAS has sufficient efficiency, Rasch reliability, concurrent validity, responsiveness, and test-retest reliability in persons with subacute stroke.[24,25]

Knowledge Gaps and Future Research

- Stroke recovery varies widely, yet there is no established end point for rehabilitation. Many survivors continue to improve or experience evolving needs months or years after stroke, making it difficult to determine when formal assessment of disability and rehabilitation needs should end. Current models often focus on short-term goals, leaving long-term recovery undersupported. Research is needed to define when rehabilitation should be concluded, how to recognize continued progress, and how to structure care for lifelong recovery and adaptation to impairment.
- The relationship between patient-reported outcome measures and traditional standardized and validated measures of disability requires further exploration to determine how best to use these measures to inform the treatment, care transition, and discharge planning processes.[28] While CAT is a promising tool designed to streamline the assessment of motor function, postural control, and basic ADLs, studies have been limited to the subacute stage of recovery. Further research is warranted to determine its impact across the continuum of care.

4.2. Assessment of Motor Impairment, Activity, and Mobility

Recommendations for Assessment of Motor Impairment, Activity, and Mobility
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-NR	1. In persons with stroke, handheld or isokinetic dynamometry is recommended to quantify upper and lower extremity muscle weakness, inform the treatment plan, and monitor progress and recovery/functional gains.[1–6]
1	B-NR	2. In persons with stroke, a standardized assessment should be performed to assess upper extremity and lower extremity motor impairments to inform the treatment plan and document progress and functional gains.[5,7–12]
1	B-NR	3. In persons with stroke with walking capacity, mobility assessment with valid measurement instruments should be performed to inform the treatment plan and monitor progress and functional gains.[5,10–18]
1	B-NR	4. In persons with stroke, valid measurement instruments should be used to assess upper extremity function to inform the treatment plan and monitor progress and functional gains.[5,9,10,12,19,20]
2a	B-NR	5. In persons with stroke, it is reasonable to use a valid measurement instrument to assess muscle tone.[5,10,21,22]
2a	B-NR	6. In persons with stroke, wearable sensors/technology (eg, accelerometers, inertial measurement units, step count monitors) can be useful for objectively assessing real-world activity and participation to monitor recovery.[23–28]
2a	B-NR	7. In persons with stroke, the use of patient-reported outcome measures can be beneficial to assess the person's own perception of their motor impairments, activity limitations, and participation to deliver patient-centered care.[29]
2b	B-NR	8. In persons with stroke, balance assessment with a valid measurement instrument may be useful to inform the treatment plan, document response to rehabilitation, and monitor progress.[5,10,11,17,18,30]
2b	B-NR	9. In persons with stroke, applying the results of established algorithms to patient biomarkers or clinical data may be useful to develop appropriate treatment plans and inform individuals and caregivers of expected recovery.[31–35]

Synopsis

Motor impairments are often the most visible and are common after stroke when the stroke lesion includes the corticospinal system; that is, the motor cortical areas and the corticospinal tract.[36] Indeed, the extent of damage to the corticospinal system is predictive of motor outcomes and response to treatment.[37–39] Motor impairment assessment guides the clinician in understanding what may underlie the observed limitations in activity. In turn, assessment of activities such as upper extremity function, balance, and mobility quantifies the functional consequences of the motor impairments. Accurate assessment provides prognostic information[40–44] and guides selection of the most appropriate motor interventions for each individual.[45]

Assessment of motor impairments and activity is critical for delivering value-based, high-quality rehabilitation services to persons with stroke. Assessment results are instructive to determine who would benefit from further services, what types of services are required, what is the most appropriate setting for those services, which interventions to select, how to tailor the interventions to individual patients, and whether the rehabilitation services are achieving the desired outcomes.[46–48] Implementation of standardized assessments within and across rehabilitation settings promotes clear communication among clinicians, efficiency in treatment planning and goal-setting, and continuity of care for patients.[49–51]

Recommendation-Specific Supportive Text

1. The consequences of a stroke depend on the site of the lesion, but 1 of the most common sequelae is hemiplegia[52] and the subsequent loss of muscle strength.[53] Decreased muscle strength is one of the primary impairments underlying activity limitations, making restoration of muscle function a rehabilitation priority. Valid, reliable, and objective assessment of muscle strength is important for documenting the recovery and responsiveness to an intervention. Isokinetic dynamometry is considered the criterion standard when assessing muscle strength,[3] and this tool is a reliable assessment of muscle strength in patients poststroke. Isokinetic dynamometry may not be available in all clinical settings, and patient setup may be time-consuming. Handheld dynamometry provides an objective, reliable alternative to assess poststroke muscle weakness. Handheld dynamometry is less expensive, requires less setup, and has a smaller footprint than isokinetic dynamometry.
2. Poststroke motor impairments are not only due to muscle weakness but also to the inability to move joints selectively, outside of a pathologic obligatory synergy pattern. The Fugl-Meyer Motor Assessment can complement a strength assessment to provide a more robust picture of motor impairments to develop a targeted treatment plan. Its psychometric properties have been examined extensively, and adequate properties have been confirmed. It is therefore considered the gold standard for comparing other measures for the assessment of impairments in body function and structure. However, its length to complete can be a limitation in clinical practice, and therefore, it has not been widely adopted, despite its strengths.

3. Use of standardized assessment tools is considered a best practice to evaluate the magnitude of gait deficits, monitor response to therapeutic intervention, and set patient-centered goals.[54] Gait speed is an important outcome of stroke rehabilitation as it is essential for community ambulation,[55] associated with balance,[56] important to health-related quality of life,[57] and a predictor of survival.[58] The distance-limited 10-Meter Walk Test is a valid and reliable measure of walking capacity. The time-limited 6-Minute Walk Test (6MWT) provides a measure of patients' endurance, a complement to patients' speed. The Timed Up and Go test provides a more comprehensive timed evaluation of basic mobility skills as the test includes standing up, walking, turning, and sitting down. The 6-Minute Walk Test and Timed Up and Go are both reliable and valid assessments for individuals poststroke.
4. Similar to gait and mobility measures, objective, standardized assessment tools should also be used to evaluate upper limb function. The Action Research Arm Test, Wolf Motor Function Test, and Box and Blocks Test are all valid and reliable assessments in individuals poststroke. All 3 assessments require grasp, transport, and release of objects. Of the 3, the Wolf Motor Function Test is the most functional assessment as it utilizes ecologically valid items such as turning a key in a lock; picking up a pencil, a paper clip, and a soda can; and stacking checkers. The Action Research Arm Test consists of 19 tasks that are less ecologically valid than the Wolf Motor Function Test but are still functional as they require grasp, release, and transport of blocks, cylinders, and ball bearings. The Box and Blocks test is the least functional, as it requires individuals to pick up a block, transport it horizontally over a barrier, and then release it. Whereas the Wolf Motor Function Test and Action Research Arm Test can take 15 minutes to complete, the Box and Block test is time-limited, scored as the number of blocks successfully transported in 60 seconds.
5. Spasticity is clinically manifested as a resistance to passive stretch. This resistance may be attributed to both neural and non-neural components.[59] The neural component, a velocity-dependent increase in the tonic stretch reflex, is most often referred to as spasticity. Non-neural factors, such as changes in the mechanical properties of collagen, tendons, and muscle fibers, also contribute to the resistance.[60] This dual contribution of neural and non-neural causes of increased passive movement resistance makes measuring spasticity difficult. The most commonly used clinical tools for measuring spasticity are ordinal scales that measure response to passive movement (eg, Modified Ashworth Scale [MAS]). These noninstrumented scales may not be considered objective because they are subject to the rater's interpretation.[61] Little evidence exists on the psychometric properties of clinical spasticity assessment tools in patients poststroke. For most tools, data on validity and reliability are insufficient to make informed clinical decisions on the assessment of spasticity in patients with stroke.
6. Three-dimensional kinematic motion analysis systems are the gold standard for gait and upper extremity movement assessment and are reliable for measurement in persons with stroke. However, they are expensive and require a large footprint and a multimember team to operate. In contrast, wearable technologies are low-cost, are easily and efficiently applied, and allow for continuous monitoring outside of the clinic and into the home and community environment.[62] Emerging wearable technologies can provide new opportunities to enhance assessment and rehabilitation poststroke. Wearable devices allow capture of mobility and physical activity performance in different free-living settings, and clinical access to this data can potentially assist with earlier identification of functional decline and improve the timeliness of referrals and rehabilitative care.[63,64] Patients are referred to and seek out rehabilitation services to improve their performance of activities in daily life, as indicated by self-reported rehabilitation goals.[65] Advancements in wearable motion sensors now allow for direct measurement of movement performance in daily life. Sensor-derived variables can provide relevant information specific to patient goals that can be used for clinical decision-making.[66]
7. The subjective experiences and emotions of persons with stroke regarding their participation in daily activities and social roles are far more intricate than what can be captured through objective clinical assessments. Patient-reported outcome measures offer valuable insights into the experiences and perceptions of persons with stroke specific to their participation in various life activities. Considering the participation dimensions (ie, satisfaction, frequency, and meaningfulness), which are inherently client-centered and emphasize each individual's unique perspective and cultural values, the chosen assessment tool or outcome measure must be based on patient self-report. This approach ensures that evaluations are grounded in the clients' subjective experiences, offering a more nuanced and

Table 4. Common Measures of Impairment, Activity, and Mobility

Construct/measure	Comments	Approximate time to administer, min
Impairment		
Paresis/strength[1–6]		
Muscle strength	Via handheld or isokinetic dynamometry	<5
Grip, pinch dynamometry	Grip and pinch dynamometers are available in most rehabilitation clinics and hospitals; normative data are available for comparison	<5
Tone[1,4,5]		
MAS	Quantifies spasticity on a scale measuring resistance to passive movement from 0–4, with higher numbers indicating greater severity; can assess at all joints or only a few	10
Sensorimotor impairment measures[1–5,7–9]		
Fugl-Meyer	Quantifies sensorimotor impairment of the UE (0–66 points) and LE (0–34 points) on separate subscales; items are rated on ability to move out of abnormal synergies	UE: 20 LE: 10
Activity		
UE function[1,4,5,8–12,67]		
Action Research Arm Test	Criteria based on 19 items; scores are from 0–57, with normal=57; allows observation of multiple grasps, grips, and pinches	15
Box and Block Test	Score is the number of blocks moved in 1 min; higher scores equal better performance; normative data are available for comparison	<5
Wolf Motor Function Test	Time- and criterion-based scores on 15 items; contains some isolated joint movements and some functional tasks	20
Balance[13–18]		
Berg Balance Scale	Criterion-based assessment of static and dynamic balance; widely used in multiple settings	15
Functional Reach Test	A single-item test that measures how far one can reach in standing; normative data are available for comparison	<5
Functional Gait Assessment	A battery of 10 tasks to assess postural stability during walking, each scored on a 0–3 scale	15
Mobility[14–16,19]		
Walking speed (10MWT)	Brief and widely used; categories based on speed are: <0.4 m/s=household ambulation 0.4–0.8 m/s=limited community ambulation >0.8 m/s=community ambulation; normative data available for comparison	<5
Timed Up and Go	Quantifies more than straight walking, including sit/stand and a turn; scored by time to complete; criterion values available for comparison	<5
6-Minute walk test	Quantifies walking endurance; normative and criterion values for community ambulation distances available	<10

LE indicates lower extremity; MAS, Modified Ashworth Scale; UE, upper extremity; and 10MWT, 10-Meter Walk Test.

comprehensive understanding of their engagement and outcomes.[68]

8. One of the main causes of disability in patients with stroke is impaired balance. This lack of stability increases the risk of falls, restricts patients' basic ADLs, and can reduce their participation in society.[69] Assessment of balance impairment can help identify individuals at risk of falling and evaluate the outcomes of rehabilitation interventions with the use of standardized assessment tools in clinical practice. Which assessment one chooses to use will depend on the functional level of the person. The Berg Balance Scale, a 14-item assessment, has the most widely studied psychometric properties in persons poststroke. While the Berg Balance Scale's items primarily assess balance within one's base of support, the 10-item Functional Gait Assessment evaluates postural stability during walking while performing multiple motor tasks. The Timed Up and Go test includes an assessment of one's ability to rise from a chair, walk, turn around, and return to a sitting position.[70] The simplest of these measures is the Functional Reach Test,[71] which measures the maximum distance one can reach forward while standing in a fixed position without taking a step. All of these measures possess acceptable levels of reliability and validity in persons poststroke.
9. Recovery of motor function after stroke is difficult to predict for individuals.[72] Patients with similar initial impairment may achieve widely disparate levels of motor function and independence.[73] Algorithms are currently available to guide clinicians in predicting

poststroke upper extremity recovery, which can be used to develop parsimonious treatment plans and set informed rehabilitation goals.

Knowledge Gaps and Future Research

- There are numerous instrumented and noninstrumented clinical measures for assessing spasticity among patients poststroke; however, the evidence in support of the validity and reliability of these measures is lacking. There is currently insufficient psychometric evidence to recommend one tool over the others.
- Machine learning and predictive algorithms are currently available to predict upper limb recovery but have yet to be developed for the lower extremity.
- As an alternative to the full Fugl-Meyer Motor Assessment for the Upper and Lower Extremity, the Simplified Fugl-Meyer has been developed,[74] and psychometric properties established with acceptable levels of reliability, validity, and responsiveness to change.[75,76] Future research should include clinicians' perceptions of the clinical utility of this simplified, streamlined assessment.

4.3. Assessment of Communication Impairment

Recommendations for Assessment of Communication Impairment
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-NR	1. In persons with stroke, screening and assessment of communication should include speech, hearing, and nonverbal and verbal language, including pragmatic language and cognition, by a speech-language pathologist to determine rehabilitative targets, provide education, and monitor progress.[1]
1	B-NR	2. In persons with stroke, the assessment of communication should include formal and informal valid measurement instruments, including patient-reported outcome measures, performance-based instruments, clinician-reported instruments, and interviews at baseline and for reassessment to identify treatment targets for speech-language services.[1]
1	B-NR	3. In persons assessed for communication impairments after stroke, consideration of personal factors, including cultural background, prestroke language use, dominant language used, and use patterns, is recommended for optimal diagnosis, treatment planning, and enhancement of social connection and therapeutic rapport.[2,3]
2a	B-NR	4. In persons with communication impairments after stroke, the inclusion of discourse or connected language tasks as part of the assessment can be beneficial to identify subtle communication use disorders in speech, apragmatism, and aphasia, and inform the treatment plan.[4–7]
2a	B-NR	5. In persons referred for a communication assessment after stroke, use of telerehabilitation is reasonable when face-to-face assessment is not possible or when facilitating access to skilled speech-language pathology services is impractical.[8,9]

Synopsis

Impaired communication after a stroke can be detrimental to social, occupational, and personal well-being. Diagnostic considerations continue to include the comprehensive, formal assessment of speech, hearing, and nonverbal and verbal language capabilities from a speech-language pathologist (ie, written language, gestures, pragmatics, etc.). Increasingly, high-level, functional, and pragmatic communicative interactions that require language samples above the word and sentence levels are being recognized as important and sensitive to communication disorders after stroke, beyond traditional measures.[5,6,10] This is especially true considering that prestroke language use history, language dominance, and language use patterns are essential to a comprehensive assessment.[2] This is consistent with the WHO ICF framework[11] and ASHA's principled guidelines for clinical practice.[12] Guidelines for eliciting language at the discourse level in clinical settings have been proposed for apragmatism,[13] and a picture description task is now included in the NIHSS,[4] with empirical support substantiating this task as an important complement to the NIHSS. Finally, poststroke cognitive impairment, or the disruption of various processes, including thinking, memory, concentration, and decision-making,[14] can exist in parallel with aphasia and apragmatism. Poststroke cognitive impairment must be considered during the evaluation of individuals with communication impairment.

Recommendation-Specific Supportive Text

1. The assessment of communication disorders after stroke routinely occurs within the ASHA's scope of practice[15] and the preferred practice patterns[16] of speech-language pathology. Diagnostic outcomes are expected to identify and describe competencies and capabilities with speech, language production, language comprehension, prosody, hearing, cognition, the impact of these poststroke changes on functional communication skills, motivational barriers and facilitators, and potential for implementing compensatory behaviors. This practice is consistent with the WHO ICF, Commission on Social Connection,[17] and other international stroke guidelines.[18]
2. Complexities associated with communication disorders after stroke necessitate the use of many

different forms of assessment, with decisions concerning the use of static, dynamic, or a combination of both, ecologically valid standardized and nonstandardized methods, made at the discretion of the speech-language pathologist. Consideration of the cognitive, hearing, speech, and language capabilities of the individual with stroke is necessary.[15] There are limited standardized, norm-referenced, or criterion-referenced assessments of pragmatic language.

3. Culture influences communication after stroke. Indeed, varying communication styles may affect diagnostic interactions and rehabilitative decisions with the stroke care team. In an analysis of speech-language pathology practice and curriculum, a sample of speech-language pathologists rated the culturally responsive practice of individualizing assessments as moderately important to important (3.6/5.0).[19] Thus, much more research is needed to develop culturally sensitive diagnostic tools for communication disorders.
4. The inclusion of discourse in the assessment process is an increasingly important ecologically valid approach, with technological advances reducing the associated transcription and coding burden.[20] While not widely adopted, researchers have outlined the use of indirect and direct tasks for the assessment of linguistic (ie, language comprehension and language production) and extralinguistic (ie, gestures and facial expressions) domains of language. TalkBank, AphasiaBank and the RHDBank databases offer standard administration protocols for eliciting discourse and capturing population-specific clinical information.[13,20,21]
5. Telerehabilitation offers access to communication diagnostics that were previously unavailable. However, increased access to skilled communication assessments via telerehabilitation approaches necessitate careful consideration of the components of the clinical assessment, the platforms being used to administer the assessments, and the presence of cognitive, speech, and language disorders. While standardized assessments for communication after stroke exist, most lack reliability and validity for aphasia when administering via telerehabilitation platforms.[22] Telerehabilitation assessment guidelines are needed to systematize and standardize approaches and diagnostic measures.

Knowledge Gaps and Future Research

- Guidelines are needed to support telehealth usage that can accommodate and compensate for cognitive and linguistic deficits to increase access.
- Additional research is needed to target the assessment of language disorders beyond aphasia to those experienced after right hemisphere stroke – apragmatism.
- More research is needed to determine the valid and reliable assessment of hearing after stroke and the specific role that acquired hearing impairments play in the assessment of communication after stroke.

4.4. Assessment of Cognition and Perception

Recommendations for Assessment of Cognition and Perception
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-NR	1. In persons with stroke, the use of brief multidomain performance-based measurement instruments with good diagnostic accuracy for detecting overall cognitive function, executive function, and perception is recommended to screen for cognition or perception impairments.[1–13]
1	B-NR	2. In persons with stroke who may have cognition or perception impairments, a comprehensive evaluation with validated performance-based instruments and real-world activities is recommended to inform treatment planning.[3,4,6,8,14–17]
2a	C-LD	3. In persons with stroke, the use of a culturally adapted valid measurement instrument is reasonable when attempting to identify patients who may have cognition or perception impairments.[18]
2b	C-LD	4. In persons with stroke with mild to moderate cognition or perception impairments, it may be reasonable to administer brief, multidomain performance-based neuropsychological screening instruments either in-person or via telehealth to screen for cognition and perception impairments.[19–23]

Synopsis

Approximately 50% of patients with acute stroke have cognition or perception impairments.[24] These impairments may be new or due to comorbid sequelae, such as sleep apnea, fatigue, or sedating medications,[25–28] or preexisting cognitive impairments.[29–31] Whether new or preexisting, these impairments are associated with prolongation of recovery, exacerbation of physical disabilities, and loss of independence.[32–34] Furthermore, acute poststroke cognition impairments increase the risk for dementia.[35–37] These consequences may be prevented or ameliorated with early detection and robust rehabilitation.

Screening is recommended in the acute phase to identify stroke patients with cognition and perception impairments.[2,4,7,9–13] Diagnostic accuracy may be influenced by culture and language.[18] Repeated screening at regular intervals is also recommended to detect and manage cognitive impairments and potential cognitive decline given the elevated risks for vascular cognitive impairment and dementia. Selected brief, multidomain performance-based screening instruments such as the Montreal Cognitive Assessment or the Oxford Cognitive

Table 5. Screening Measures for the Assessment of Cognition and Perception

	Description	Domains	Scoring	Performance in the stroke population
MMSE[43]	Brief (10-min) instrument developed to screen for cognitive decline associated with dementia	Time and location orientation, verbal memory, attention and working memory, language, and visuospatial figure copying	30 points total; 22 or lower may indicate impairment Requires intact verbal ability and manual dexterity to obtain a valid total score[44,45]	MMSE does not assess executive function; MMSE is not sensitive to common poststroke cognitive impairments such as spatial neglect, apraxia, and aphasia[9,46]; studies raise concerns about reliability and clinical utility[44,45]
MoCA[47]	Brief (10-min) instrument developed to screen for early signs of mild cognitive decline	Time and location orientation, verbal memory, attention and working memory, visuospatial and executive function, and language	30 points total; 25 or lower may indicate impairment Requires intact verbal and visual abilities, and manual dexterity to obtain a valid total score[47]	MoCA assesses executive functions, but studies raise concerns about reliability; MoCA is not sensitive to common poststroke cognitive impairments such as spatial neglect, apraxia, and aphasia; when compared with MMSE, MoCA has greater diagnostic accuracy (sensitivity and specificity)[7] relative to independent evaluation batteries
OCS[48]	Brief (15-min) instrument designed to screen for stroke-specific cognitive impairments in the acute-subacute stage (within 2–3 weeks poststroke), without being hindered by aphasia or spatial neglect	Time and location orientation, visual field screening, verbal and visual memory, attention and working memory, number writing and calculations, visuospatial and executive function, praxis, and language; OCS-Plus,[49] includes additional executive function items	No total score or a cut point for the entire battery; normed cut points identify impairment in each task. Does not require intact verbal or visual abilities, or manual dexterity to obtain valid screen	When compared with MMSE and MoCA, OCS has the highest diagnostic accuracy and is more inclusive for individuals with aphasia or spatial neglect, relative to an independent evaluation battery[3,50]

MMSE indicates Mini-Mental Status Examination; MoCA, Montreal Cognitive Assessment; and OCS, Oxford Cognitive Screen.

Screen have good diagnostic accuracy in patients with stroke[1,3] and may be administered in-person or via telephone or videoconference.[20–22] However, these instruments may not detect executive function or perception impairments,[5,6,8,9] and screening in these domains is also recommended.

For patients with stroke with cognition or perception impairments, screening should be followed by a comprehensive evaluation administered, scored, and interpreted by formally trained personnel. Neuropsychological performance[3,4,6,8] should be evaluated, along with cognitive and perceptual functional activity performance[14,15] and patient-reported outcomes to inform care management and to track changes over time.[16]

Recommendation-Specific Supportive Text

1. Given the prevalence and disabling impact of cognition and perception impairments after stroke,[24,32–34] screening is strongly recommended. Five systematic reviews,[2,4,7,9,10] 1 meta-analysis,[10] and 2 recent large observational studies examined[11,13] the diagnostic accuracy of brief multidomain performance-based screening instruments in patients with stroke. The MMSE and the Montreal Cognitive Assessment (MoCA), the 2 most studied screening instruments, have good diagnostic accuracy for detecting severe cognition impairments associated with dementia risk in patients with chronic stroke.[10,11,13] However, relative to other brief screening instruments, the MoCA and the Oxford Cognitive Screen (OCS), which was developed and validated in patients with acute stroke,[1,3] show the best diagnostic accuracy for detecting cognition impairments in patients with acute stroke, as well as in patients with subacute and chronic stroke with mild to moderate cognition impairments.[2,3,5,7] One well-designed observational study concluded that the OCS was more sensitive than the MoCA for detecting stroke-specific cognition impairments (eg, spatial neglect, apraxia, and reading/writing ability).[3] That said, several observational studies concluded that brief, multidomain screening instruments are only modestly correlated with instruments measuring executive functions.[5,6,8,9] Furthermore, with the exception of the OCS, most brief, multidomain screening instruments do not assess perception.[9] Thus, screening should include brief performance-based instruments that assess executive functions and perception.
2. Observational studies illustrate that most instruments measuring cognition or perception have good psychometric properties for assessing specific domains or cognitive abilities in patients with stroke but are often modestly correlated with other cognition or perception measurement instruments.[3,4,6,8,17] This includes studies that examined convergent validity between neuropsychological instruments and brief, performance-based instruments that assess cognitively or perceptually focused functional activities (eg, functional cognition).[14,15] Furthermore, performance on neuropsychological instruments is modestly correlated with subjective cognitive reports from community-dwelling patients.[16]
3. A systematic review of 54 observational studies examining the diagnostic accuracy and population-adjusted cut points of various cultural adaptations of the MoCA, the OCS, and the MMSE for detecting

cognition impairments in patients with stroke.[18] Even with translation and cultural adaptation of each of these 3 screening instruments, diagnostic accuracy and optimal cut points for detecting cognition impairments differ greatly among various culturally defined populations. Furthermore, population-adjusted cut points (ie, normed scores based on age, sex, or education) vary within culturally defined populations. However, conclusions are limited due to the heterogeneity of study designs and the need for additional studies of diagnostic accuracy and population-adjusted cut points across culturally adapted versions of these instruments.

4. One observational study suggests that it is feasible to administer a computerized battery of cognition screening instruments within the first week after stroke.[19] The diagnostic accuracy of this approach in patients with acute stroke requires further investigation. A separate observational study with a randomized crossover design suggests that videoconference administration of the MoCA generated total scores in patients with subacute and chronic stroke with mild to moderate cognition impairments, that were comparable to in-person administration. However, there may be some differences in reliability and measurement precision between administration methods.[20] An additional analysis with the same cohort and design comparing in-person and videoconference administration of a comprehensive neuropsychological battery reported similar findings for all instruments in the battery except for the Hopkins Verbal Learning Test-Revised, which was associated with poorer performance when administered via videoconference.[21] A secondary analysis of patients with chronic stroke revealed that OCS administered via telehealth (telephone or video conference) has good sensitivity and excellent specificity for detecting cognitive impairments relative to a comprehensive multidomain evaluation.[23] Similarly, a large observational study reported that the Telephone Interview of Cognitive Status and telephone-administered Montreal Cognitive Assessment had good discriminant validity for identifying potential patients with chronic stroke who may have mild cognitive impairment and associated risk for dementia,[22] and therefore could be used to identify patients with chronic stroke who need a more comprehensive multidomain evaluation.

Research Gaps and Future Research

- Overall, research is needed to inform cognition and perception measurement strategies in patients with stroke (eg, diagnosis, care planning, intervention response, long-term cost-effectiveness) to be consistent with the COnsensus-based Standards for the selection of health Measurement Instruments (COSMIN).[38] Evidence supports the use of screening instruments to detect poststroke cognition impairments, but these same screening instruments are also being used to inform care planning or to measure change due to recovery or intervention. Instruments have different psychometric properties for screening (eg, diagnostic accuracy) than for care planning (eg, structural validity) and outcome measurement (eg, responsiveness).[38]
- Current evidence focuses on brief, multidomain screening instruments. Research is needed to investigate new or improve existing instruments to reliably detect impairments in patients with stroke in specific cognition and perception domains, including executive function and perception. Furthermore, research is needed to examine the validity of cultural adaptations of these instruments.
- Research is needed to identify cognition and perception measurement instruments that distinguish severity levels (for care planning) and responsiveness (for outcome measurement). Comparatively few instruments are validated as outcome measures for patients with stroke, particularly those with acute stroke with sensory, motor, language, and perceptual impairments that may impede testing.
- Research is needed to further validate digital, videoconference, and telephone-based methods for assessing cognition and perception impairments in patients with stroke.
- Consensus panels recommend that cognition and perception assessment should be administered, scored, and interpreted by formally trained personnel.[39–42] Research is needed to inform resource allocation for timely and accurate assessment and clinical decision-making.
- Research is needed to develop and validate culturally sensitive assessments of cognition and perception.

4.5. Assessment of Sensory Impairments, Including Touch, Vision, and Hearing

Recommendations for Assessment of Sensory Impairments, including Touch, Vision, and Hearing
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-NR	1. In persons with stroke, comprehensive evaluation of sensory impairments, including somatosensation, vision, and hearing, is recommended to identify sensory impairments and inform the treatment plan.[1–5]
1	B-NR	2. In persons with stroke, performance-based visual screening is recommended instead of self-report alone to identify individuals with visual impairments and inform the treatment plan.[6–8]

Synopsis

Persons with stroke frequently experience impairments involving multiple sensory domains including somatosensation, vision, hearing, taste, smell, and vestibular function (see section 5.4, "Balance and Ataxia"). Somatosensory function, in particular, is crucial for motor recovery.[9] These impairments are associated with greater disability, decreased motor recovery, and poor quality of life.[2,10] Most sensory assessments are designed to evaluate specific sensory domains, rather than overall sensory function. Therefore, a comprehensive battery of validated measures that is both sensitive and specific should be administered to assess sensation and inform intervention. Given the high prevalence of visual impairments poststroke, persons with stroke should be screened for visual impairments to ensure appropriate referrals and treatment are provided.[11,12] In addition, both movement and position sense should be included as part of a comprehensive somatosensory evaluation.[13] Finally, hearing assessments should evaluate both peripheral and central auditory function.[14] Sensory impairments can occur bilaterally, though these impairments are typically milder on the ipsilesional side of the body.[14–16] Therefore, the extent of impairment on the contralesional side may be underestimated if the extremities are compared with one another.[16] Since many individuals are unaware they have sensory impairments,[4,7,14,17–20] performance-based assessments should be administered in combination with self-report measures to ensure that impairments are identified accurately.

Recommendation-Specific Supportive Text

1. A prospective longitudinal study of 101 participants found that most persons with acute stroke experience 1 or more somatosensory impairments (eg, light touch, proprioception, temperature discrimination).[2] Although somatosensory impairments are significantly less frequent over time, many individuals experience persistent impairments at 6 months[21] and 1 year poststroke.[2] Two large prospective epidemiological studies and 1 observational diagnostic study found a high incidence and prevalence of visual impairments poststroke.[4,11,17,22] Specifically, individuals frequently experience central visual impairments, visual field loss, and ocular motility deficits.[4] A case-control study found that hearing impairments are more common among persons with stroke compared with age-matched controls.[14] Individuals may experience peripheral hearing loss, central auditory processing deficits, or both impairments.[14] Findings from a diagnostic study of 42 participants with stroke found that a handheld hearing screener had the highest sensitivity (92.59%) and specificity (100%) for detecting peripheral hearing loss when compared with 2 self-report questionnaires (modified Amsterdam Inventory Auditory for Disability, Hearing Handicap Inventory for Elderly). This study also found that a handheld screener combined with the Amsterdam Inventory Auditory for Disability had the highest sensitivity (50%) and specificity (88.89%) for detecting central auditory processing deficits when compared with other measures.[3]
2. Although visual impairments are common, findings from an epidemiological study by Rowe et al found that approximately 50% of patients with acute stroke with visual impairments do not self-report symptoms.[12] A prospective multisite study of 141 persons with stroke also found that many individuals do not self-report vision symptoms after stroke. These findings underscore the need for early visual assessment to ensure that individuals with visual impairments are identified and treatment is provided, since self-report alone may not identify all individuals with visual impairments. Evidence from 3 prospective observational studies and 1 epidemiological study also supports the feasibility of assessing individuals with acute stroke for visual impairments.[11,22–24] Findings also suggest that non–vision specialists can accurately identify visual impairments using screening tools, facilitating timely referral to appropriate vision specialists.[6,8,24] However, there is a lack of evidence and consensus regarding the specific battery of assessments that should be used to optimally assess for the wide range of visual impairments that can occur poststroke.[7,25]

Knowledge Gaps and Future Research

- Additional research is needed to further establish the psychometric properties (eg, inter-rater reliability, intra-rater reliability, test-retest reliability, internal consistency, content validity, criterion validity, responsiveness) of sensory assessments, particularly those that assess somatosensory domains.[1,13,26–28] Few measures comprehensively report these properties or have limitations.
- Although impairments in taste and smell are common after stroke and can impact quality of life,[19,29] they are not routinely assessed, partly due to a lack of standardized assessments.[29] Research is needed to develop and validate measures to assess for olfactory and gustatory function.[29]
- Research is also needed to establish a battery of standardized assessments that can be used to comprehensively assess stroke survivors for sensory impairments.

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5. SENSORIMOTOR IMPAIRMENTS AND ACTIVITIES

5.1. Physical Activity

Recommendations for Physical Activity
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	A	1. In persons with stroke, an individually tailored exercise program is indicated to optimize physical health, including cardiorespiratory fitness and mobility, and to reduce the risk of future vascular events.[1–7]
1	A	2. In persons with stroke, participation in a program of exercise or physical activity commencing in rehabilitation and continuing at home or in the community is recommended to optimize cognitive health.[8–15]
1	A	3. In persons with stroke, exercise guidelines of 150 to 300 minutes of moderate-intensity physical activity per week, with 3 to 5 days per week of aerobic training and 2 to 3 days per week of strength training and balance training are recommended to achieve health benefits.[5]
1	C-EO	4. In patients with stroke, clinicians working collaboratively with persons with stroke, while keeping exercise guidelines and the person's preferences in mind, is recommended to determine an appropriate and achievable physical activity program.
2a	B-R	5. In persons with stroke, exercise programs combined with behavior change techniques can be beneficial to increase daily physical activity.[16–22]
2a	C-LD	6. In persons with stroke, physical activity can be measured with valid measurement instruments, devices, and other technology to guide physical activity planning with the patient and caregivers.[23]

Synopsis

After a stroke, people spend most of their day inactive, whether the time poststroke is in the acute, subacute, or chronic phase.[24] A stroke can compromise cardiorespiratory fitness by affecting muscle physiology, peripheral blood flow, and the autonomic control of cardiac regulation.[25] Stroke-related impairments such as hemiparesis and impaired balance can make independent mobility difficult or even unsafe for some, leading to a loss of confidence and fear of falling. These physical and psychological effects can cause a vicious cycle of deconditioning, physical inactivity, avoidance of activities, and deterioration of health. Recurrent stroke is common, with 1 in 10 persons going on to experience another stroke within the first year poststroke.[26] Physical inactivity is a modifiable risk factor; it is 1 of the highest risk factors of a recurrent stroke, myocardial infarction, or vascular death.[7] While introduction to structured exercise typically occurs during formal rehabilitation therapy, the health care team plays an important role in facilitating the incorporation of physical activity into patients' daily routines to optimize recovery and secondary prevention over the long term.

Recommendation-Specific Supportive Text

1. A symptom-limited or submaximal stress test should be part of medical clearance prior to exercise.[27,28] Submaximal field tests (eg, 6-Minute Walk Test) may be an appropriate substitute for an exercise stress test if the exercise intensity is at the lower end of the exercise intensity (eg, <50% of heart rate reserve).[28] Several recent RCT meta-analyses,[1,3–5,29] including 1 Cochrane review,[6] support regular physical activity, especially with aerobic and resistance training, to improve mobility, cardiovascular fitness, and stroke risk factors, including blood pressure, lipid, and glucose profiles.[30] One exercise study (n=70) reported a reduction in vascular events (eg, recurrent stroke, myocardial infarction) as their primary outcome, with 24 weeks of exercise and salt education.[2] In a subanalysis of the SAMMPRIS study control group (n=227), patients with stroke who were physically inactive had 5 times the chance of having a stroke, myocardial infarction, or vascular death, compared with active patients.[7] A meta-analysis of aerobic studies (including 11 subacute studies) found that aerobic exercise was well tolerated with minimal adverse events.[29] Exercise has been recommended along the continuum of stroke recovery, especially early after stroke, to minimize the detrimental effects of bed rest and capitalize on the heightened neuroplasticity present during the early poststroke period. However, caution should be exercised in the acute stroke period within the first 24 hours, as a large multisite study (n=2104) found that higher doses of standing and walking beginning within this time frame resulted in greater disability and mortality.[31]
2. An 80% higher risk of dementia occurs in people with stroke compared with people without a stroke, and this is reflected by 1 in 5 persons with stroke being diagnosed with dementia.[32] Recent meta-analyses support improved aspects of cognition with exercise.[11,15] For example, in the subacute setting, 12 weeks of aerobic and strength training exercise started within 1 month of a transient ischemic attack or minor stroke, followed by 3 sessions of exercise counselling over the next 9 months, improved executive function (n=119), but not global cognitive function, and this effect persisted for at least 2 years of follow-up.[8] Higher-intensity walking during subacute inpatient rehabilitation improved global cognition (MoCA; n=75) compared with usual care physical therapy.[14] In the chronic setting, a 6-month fitness and mobility exercise program improved global cognition compared with a social enrichment or light-intensity exercise program (n=120).[13] Six months of aerobic exercise

improved global cognitive function in people with ischemic vascular cognitive impairment versus usual care (n=70).[12] An 8-week high-intensity interval training program in patients with chronic stroke (n=70) resulted in improvements in executive function compared with usual care.[9] A 4-year longitudinal study (n=223 426) found that moderate-to-vigorous physical activity was an independent variable significantly associated with a lower risk of developing dementia after stroke.[33]

3. The WHO recommends that adults living with disability complete at least 150 to 300 minutes per week of moderate-intensity aerobic physical activity; or at least 75 to 150 minutes per week of vigorous-intensity aerobic physical activity. Muscle-strengthening activities that involve all major muscle groups should be performed 2 or more days per week. Functional balance and strength training should be done at least 3 days per week to prevent falls and enhance functional capacity. The AHA and ASA exercise guidelines recommend aerobic activity (3–5 d/wk), muscle strengthening (2–3 d/wk), balance or coordination exercises (2–3 d/wk), and flexibility (2–3 d/wk). Exercise interventions that adhere to physical activity guidelines have more favorable outcomes on physical and cognitive health.[5,34] If adults living with disability are not meeting these recommendations, doing some physical activity will bring benefits to health and is better than no physical activity.[35] Exercise should be gradually progressed in difficulty and intensity to ensure a safe intervention that accommodates the individual's functional limitations, comorbidities, motivation, and goals.
4. Simply telling people to be more active is not sufficient to motivate people to undertake more physical activity or to sustain this activity over the long-term. Stroke clinicians can work collaboratively with persons living with stroke to develop individualized physical activity goals while keeping the exercise dose guidelines in mind.[27,28,36] It is critical to identify barriers and motivators and problem-solve how to overcome these barriers. Personal preferences should be explored to facilitate physical activity uptake, including the choice of activity (eg, sport, walking), setting (eg, community center, home, park), delivery mode (group, individual, online), and social support.[36] There is an increasing use of technology in the form of physical activity monitors and apps that can support goal setting, behavior change, and self-management of physical activity.[27,36]
5. Intervention strategies are needed to break the relentless poststroke cycle of reduced physical activity that leads to further reductions in functional capacity and greater risk of secondary complications. Since 2014, there have been several published meta-analyses,[18–20,22] with at least 34 individual RCTs, on different interventions incorporating more physical activity in their daily routines, demonstrating an ongoing health benefit. Exercise or active physiotherapy (beyond usual care) improves motor function, and in turn, may translate to greater physical activity.[18] Combining exercise with behavior change techniques may have greater effects than exercise alone.[19] For example, Brauer et al[17] (n=119) found that 8 weeks of treadmill walking, embedded with self-management education commenced in the subacute stage, resulted in greater daily steps (6982 steps per day) than usual care gait training (5746 steps per day). A 12-week RCT (n=250 participants with chronic stroke) found that daily steps increased in groups with daily walking feedback and goal setting, but not with a walking training–only group.[21] While the majority of studies focus on increasing physical activity, 1 study has shown that encouraging a reduction of sedentary time was more effective than encouraging physical activity.[16]
6. Quantifying activity levels can inform personalized interventions to improve adherence to physical activity. Physical activity in the hospital setting is typically structured around formal therapeutic activities. When the person with stroke returns home, they have the opportunity to develop their daily routines, including physical activity during leisure, exercise, and occupational and household activities (also known as free-living physical activity). Physical activity planning can commence prior to a person returning to the community, and physical activity can be assessed upon returning home. For clinical practice, an international consensus recommended that physical activity post-stroke be measured through activity questionnaires, as well as via devices to measure daily step count.[23] Capturing both is ideal as it provides a fuller picture of physical activity. Both of these measures can be used as indicators for the time spent in moderate-to-vigorous physical activity[36] — a metric strongly associated with cardiovascular risk factors and mortality.[37] The International Physical Activity Questionnaire and the Physical Activity Scale for the Elderly are 2 recommended questionnaires with acceptable validity

Table 6. Exercise Guidelines: Aerobic Component[27,28,35]

Days	3–5 d aerobic training
Intensity	Repetitive large muscle activities • 20–60 min/session (minimum 10-min bout) • 150–300 min/wk of moderate intensity aerobic physical activity (40%–60% HRR) or • 75–150 min/wk of vigorous-intensity aerobic physical activity (>60%–80% HRR)
Sample activities	Recumbent bike, brisk walking on ground or treadmill, arm ergometry, seated exercises moving arms and legs against gravity

HRR indicates heart rate reserve.

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Table 7. Exercise Guidelines: Strength and Balance Component[27,35]

In addition to an aerobic component, it is recommended that strength and balance training be added to an exercise program. In some cases, strength training can be combined with aerobic training. For example, repetitive sit-to-stands and step-ups onto a riser focus on lower limb muscle strength and can be done with an aerobic intensity (and can contribute to the 150–300 min of moderate-intensity aerobic physical activity outlined in Table 7). In contrast, some balance-training activities will not increase the heart rate sufficiently to reach an aerobic intensity and may not contribute to the 150–300 min of moderate intensity physical activity.		
Days	2–3 d strength training	2–3 d balance training
Intensity	Resistance or functional strengthening exercises with major muscle groups • 1–3 sets of 10–15 repetitions of 8–10 at 50%–80% of 1RM	• Activities that challenge coordination and agility. • Exercises that reduce the base of support
Sample activities	Resistance bands, free weights, resistance machines, functional strengthening (sit to stand, squats, lunges, rise up on toes)	Exercises that reduce the base of support (eg, heel-to-toe walking, tai chi, yoga), recreational sports (eg, pickleball, tennis), exergaming

1RM indicates 1-repetition maximum.

and feasibility.[36] Accelerometer-based devices (eg, Fitbit, Step Activity Monitor) are recommended to be placed on the ankle, as they demonstrate greater accuracy in slow-walking individuals when placed in this location compared with other body locations.[38] When possible, daily steps should be captured over a minimum of 2 separate days, each with at least 14 daytime hours.[23]

Knowledge Gaps and Future Research

- There are many barriers to screening procedures such as symptom-limited exercise stress tests; they are expensive, may require specialized equipment to accommodate stroke-specific impairments, and are simply not feasible to be completed on an annual basis by the majority of persons with stroke. Establishing valid exercise screening procedures that are accessible from the acute to community setting would help clinicians to facilitate safe exercise in persons with stroke.
- Regular physical activity has substantial benefits on physical and cognitive health after stroke. However, the best way to support long-term adherence to physical activity cost-effectively needs further research.
- Walking is the most common type of physical activity that persons with stroke participate in. There are very few options for people with severe stroke who may want to exercise in their home or community. Technology such as robotic devices may provide future solutions for people who cannot walk independently.

5.2. Limb Apraxia

Recommendations for Limb Apraxia
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
2a	B-R	1. In persons with stroke and limb apraxia, strategy training or gesture training can be considered to improve motor abilities.[1–5]
2a	C-LD	2. In persons with limb apraxia, task practice can be considered to reduce apraxia.[1,3,4,6,7]

Synopsis

Limb apraxia are deficits in carrying out purposeful, skilled movements that cannot be attributed to motor-sensory deficits or lack of motivation.[8] These motor cognitive impairments may result in difficulties in using an object or tool for its specific purpose, as well as imitating the use of objects or making symbolic gestures.[8] Limb apraxia is more common after left hemispheric than right hemispheric stroke.[9] Using the Familiar Tools Test of the Diagnostic Instrument for Limb Apraxia, limb apraxia has been detected in up to 15% of people with left hemispheric stroke and 3% in right hemispheric stroke in a primarily acute population.[9] The prevalence is higher in neurorehabilitation centres (about 50% of left hemispheric stroke),[10] likely due to the greater severity of stroke in this population. Limb apraxia contributes to challenges with independence in daily life activities.[11,12] Brain lesions, especially in the inferior frontal gyrus, posterior parietal lobe, and lateral occipital-temporal cortex, are associated with apraxia.[13] Understanding the anatomical functions of apraxia could lead to targeted interventions.

Recommendation-Specific Supportive Text

1. Three systematic reviews provide low-quality support, with 3 additional small RCTs since 2014 indicating that strategy training or gesture training for limb apraxia may be considered.[1,3,4] For example, 1 study (n=25 with chronic stroke) found that 5 1-hour weekly sessions of tea-making training with feedback reduced errors and the time to make tea, but these effects did not carry over to more complex tea preparation tasks.[2]
2. These systematic reviews also support task practice or functional training to improve limb apraxia.[1,3,4] For example, a chronic stroke study (n=20) compared 24 sessions over 8 weeks of virtual reality (VR) exercises (eg, simulation of food preparation, dressing) with the same amount of traditional rehabilitation activities. They found that VR reduced aspects of apraxia (ideomotor and constructive apraxia) compared with the control method.[7] Another study (n=38;

average of 12 months poststroke) found that 24 sessions over 8 weeks of upper limb functional training improved aspects of apraxia (eg, ideomotor apraxia, imitating gestures, global recognition of gestures) compared with an educational group.[6] It seems that task-practice may be undertaken in different formats (eg, functional training, VR-based training).

Knowledge Gaps and Future Research

- The optimal timing (eg, ideal time to commence apraxia training poststroke) and dosage (ideal number of sessions) require further research, especially in enabling long-term effects.
- There is some preliminary evidence that noninvasive brain stimulation may affect motor apraxia. A single session of tDCS (n=6)[14] or transcranial continuous theta-burst stimulation over the parietal regions (n=19)[15] have improved aspects of apraxia temporarily. These studies serve as a proof-of-concept, but controlled trials over longer periods are required before any recommendations about brain stimulation can be made.

5.3. Management of Spasticity

Recommendations for Management of Spasticity
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	A	1. In persons with stroke-related upper extremity spasticity, targeted injection of botulinum toxin into localized upper limb muscles is recommended to reduce spasticity, improve passive ROM and limb positioning, and improve dressing and hygiene.[1–5]
1	A	2. In persons with stroke-related lower extremity spasticity, targeted injection of botulinum toxin into lower limb muscles is recommended to reduce spasticity that interferes with gait.[6–8]
1	B-R	3. In persons with stroke-related limb spasticity, instrumented guidance for targeting muscles for botulinum injection using ultrasound, electrical stimulation, or electromyography (EMG) is recommended to improve the efficacy of the injection.[9,10]
2b	A	4. In persons with stroke with generalized spasticity, oral antispasticity agents may be useful for reducing spasticity, but may result in dose-limiting sedation, weakness, or other adverse effects.[11–14]
2a	B-R	5. In persons with stroke and severe spasticity, intrathecal baclofen therapy is reasonable for reducing spasticity that does not respond to other interventions to improve spasticity and limb positioning during care.[15–17]
2b	A	6. In persons with stroke with spastic muscles, physical modalities such as NMES or vibration applied to spastic muscles may be reasonable as an adjunct to rehabilitation therapy to temporarily improve spasticity.[18–21]

Recommendations for Management of Spasticity (Continued)

COR	LOE	Recommendations
3: No Benefit	B-NR	7. In persons with stroke, the use of splints and taping is not recommended for prevention of wrist and finger spasticity.[22]

Synopsis

Spasticity is prevalent following a stroke, affecting approximately 25% to 46% of individuals, with severe spasticity in about 10%.[23–25] It can lead to joint contractures, skin breakdown, and pain that impair functional ability and independence,[24] and can adversely affect self-care activities, such as maintaining independent hygiene and dressing, which can significantly increase the burden on caregivers. Spasticity is a form of hypertonia defined as "a motor disorder characterized by a velocity-dependent increase in tonic stretch reflexes with exaggerated tendon jerks, resulting from hyperexcitability of the stretch reflex, as 1 component of the upper motor neuron syndrome."[26] Clinical manifestations of spasticity include clonus, postural dystonia, and flexor or extensor spasms with or without pain. The likelihood of developing poststroke spasticity is heightened by having a larger volume of hemispheric injury, greater neurological severity as indicated by a higher NIHSS score, intracerebral hemorrhage, basal ganglia involvement, and sensory loss.[25,27,28] Certain voluntary movement patterns seen poststroke can be mistaken for spasticity, specifically, movement in abnormal synergy in moderate to severe strokes, which differ significantly from hypertonia, being marked by a loss of independent muscle control, leading to coupled joint actions manifesting as stereotypical flexion or extension patterns. These movement patterns can occur with or without spasticity.[29] Though spasticity and movement in synergy patterns are distinct, they both derive from altered neural drive via a hyperexcitable reticulospinal motor system, leading to diffuse motor drive and unopposed descending inputs to the spinal reflex system.[23]

Treating spasticity in stroke patients involves a comprehensive approach, aiming to improve mobility, self-care, joint protection, skin hygiene, and quality of life. Several strategies are available, including physical modalities, injections, and oral and intrathecal medications, each with their benefits and considerations.

Recommendation-Specific Supportive Text

1. Numerous randomized, double-blind, placebo-controlled trials have demonstrated that various formulations of botulinum toxin type A can reduce spasticity in the upper limb of persons with stroke. Reductions in spasticity, as measured by Ashworth score or modified Ashworth score, are significantly reduced at 4 and 8 weeks, with re-emergence of spasticity by 12 weeks postinjection.[1–5,30] Treatment-related adverse events are <3% and

nonserious.[31] Further analysis shows that improved passive function, daily disability, and caregiver burden were maintained over multiple cycles, with corresponding enhancements in patient-reported quality of life.[32] Higher doses have improved efficacy with no difference in drug tolerability.[1,4,33,34] In a systematic review of 13 studies, botulinum toxin therapy combined with rehabilitation was cost-effective compared with rehabilitation alone.[35] However, the current evidence has not confirmed that upper limb rehabilitation therapy following injection of botulinum toxin enhances outcome over injection alone.[30,36] Current evidence does not support the use of botulinum toxin therapy for reducing the risk of upper limb contracture.[37]

2. In an RCT focused on lower limb spasticity (n=381), abobotulinumtoxinA effectively reduced spasticity, with sustained benefits and improved walking speed (25.3% faster) observed in the open-label extension phase.[6] Wein and colleagues[8] evaluated the efficacy and safety of onabotulinumtoxinA in treating poststroke ankle plantar flexor spasticity, showing that 52% of those receiving toxin therapy experienced a significantly greater MAS score reduction and physician clinical global impression of change compared with the placebo group at weeks 2 to 6 after injection, with injection site pain and swelling as common adverse effects in both groups. In subgroup analysis, toxin was equally effective regardless of time since stroke.[7]
3. Focal injection of botulinum toxin is an alternative to the use of oral antispasticity agents, targeting muscles of interest and reducing the risk of systemic adverse effects. Injection targeting specific muscles contributing to spasticity is best achieved using EMG localization, ultrasound guidance, or electrical stimulation. A systematic review of 10 studies by Grigoriu and colleagues (2015) provided level 1 evidence that instrumented guidance was superior to manual needle insertion for accuracy of muscle targeting for botulinum toxin injection.[10] In a more recent Bayesian network meta-analysis of 6 studies comparing injection localization guidance techniques, ultrasound and electrical stimulation were found to be superior to EMG and manual needle placement for achieving best spasticity reduction by Ashworth score at 2 to 6 weeks following injection.[9]
4. Oral medications such as baclofen, dantrolene sodium, and tizanidine are designed to help reduce generalized spasticity. While these medications can be beneficial, they often come with adverse effects such as fatigue and lethargy, which can limit how much of the drug can be safely taken, impacting overall clinical utility.[11–14]
5. The SISTERS study[15,16] found that intrathecal baclofen (ITB) therapy is significantly more effective than conventional oral medications at reducing severe poststroke spasticity in adults with chronic stroke. In this multicenter, randomized, controlled trial, 60 patients with chronic stroke and substantial spasticity were assigned either to ITB or conventional medical management, with both groups also receiving physical therapy. ITB showed a better spasticity reduction on MAS, improved pain control, and higher quality of life at 6 months postimplant than those treated conventionally. However, ITB group patients experienced surgically related adverse events, including device dislocation and wound infection, and ITB patients had more events of weakness, urinary retention, and constipation managed with dose adjustment. Surgical placement of the catheter tip higher in the cervical region can improve upper limb spasticity control, with no increased risk of complications.[17]
6. There is some evidence for efficacy of nonpharmacologic approaches to spasticity management. Recent systematic reviews and meta-analyses of RCTs show that localized muscle vibration therapy effectively reduces spasticity and improves motor function in poststroke patients, particularly in upper muscles, at best transiently, as follow-up was limited.[18,19,21] Some studies suggest that localized muscle vibration may offer slightly greater short-term relief than whole-body vibration, likely due to targeted muscle stimulation. Lower limb muscle spasticity also responds to vibration therapy, but the impact on gait performance remains unclear. Vibration frequencies between 5 and 300 Hz delivered between 5 and 30 minutes in duration are effective.[21] NMES also delivers significant antispasticity transient benefits to upper limb muscles when combined with other therapies.[20] Overall, vibration and NMES interventions are promising, safe, and practical adjuncts to conventional poststroke rehabilitation therapies. However, future research with larger multicenter clinical trials is necessary to verify these findings.
7. A systematic review of 11 studies assessing the use of static splinting for upper limb spasticity showed that a low strength of evidence supports the use of static splinting, strong strength of evidence was found for the use of stretching devices, and low strength of evidence was found to support the use of dynamic splinting; no evidence was found for manual stretching to address spasticity.[22]

Knowledge Gaps and Future Research

- Several small clinical trials have demonstrated the potential efficacy of ESWT in reducing spasticity, with promising indications of long-term improvements in hypertonia.[38–40] However, these findings have yet to be validated through large-scale, multicenter, double-blind trials. Further research is needed to determine whether focused or radial shock wave therapy offers superior outcomes for spasticity management. Additionally, the underlying mechanisms by which ESWT alleviates spasticity remain poorly understood and warrant further investigation.

- Neuromodulation with tDCS and rTMS or theta burst stimulation has been studied as an adjunct to spasticity management[41–47]; however, well-designed studies with well-defined stimulation parameters and locations, with long-term outcome assessment, are needed to confirm the efficacy of these modalities.
- More robust research is needed to ascertain the effectiveness of physical modalities for reducing spasticity.
- There is a need for reliable and valid measurement tools able to clinically measure spasticity in terms of both neurogenic and mechanic changes.[48,49]

5.4. Balance and Ataxia

Recommendations for Balance and Ataxia
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	A	1. Persons with stroke should be prescribed and fitted with an AD or orthosis if appropriate to improve balance and decrease fall risk.[1]
1	C-EO	2. Persons with stroke should be evaluated for balance, balance confidence, and fall risk to establish an appropriate treatment plan.
2a	C-LD	3. In persons with poststroke ataxia, postural training and task-oriented therapy are reasonable for rehabilitation to improve upper extremity motor function.[2,3]
2a	B-NR	4. In persons with stroke, tai chi can be beneficial to improve balance.[4–7]
2a	B-NR	5. In persons with stroke, VR-based balance training, including gaming-based interventions to address balance impairment, can be useful to improve balance.[8–10]
2a	B-R	6. In persons with stroke, core stabilization exercises can be useful to improve balance.[11–14]
2b	B-R	7. In persons with stroke, combined cardiorespiratory and resistance training may be considered to improve cardiovascular fitness, standing balance, comfortable walking speed, and walking distance.[15]

Synopsis

Balance depends on inputs from the visual, vestibular, and somatosensory systems. These inputs are integrated and used to control anticipatory and reactive motor output to postural disturbances. Balance impairment (including postural control impairment) is common poststroke,[16–18] as stroke can affect both sensory and motor networks. Impaired balance makes it difficult to safely complete ADLs, to move about the home and community, and to return to societal participation. Balance impairments can result in low balance confidence, which in turn may further reduce activity.[19] Improving balance can decrease fall risk, but if left undetected or untreated, balance impairments can result in a cascade of serious, undesirable, and expensive events, including falls, fractures, and hospitalization.[20,21] Evaluation of balance abilities, even in those with a minor stroke (NIHSS score <4),[22]will help determine fall risk and guide the selection and tailoring of balance-specific interventions.[23–25] However, improving balance alone may not be sufficient for preventing falls because falls have multiple contributing causes.

Ataxia is a disorder of coordinated muscle activity during voluntary movement, associated with injury to the cerebellum, cerebellar peduncles, and brainstem cerebellar tracts, and it may affect both the upper and lower extremities as well as the trunk. Patients with ataxia have delayed movement initiation, timing errors, abnormal limb trajectories, and dysmetria.[3,26] Ataxia is present in 68% to 86% of patients with brainstem stroke and typically improves during acute rehabilitation.[27,28] There is a paucity of research on rehabilitation approaches to address poststroke ataxia. Research is currently limited to case studies and to decreasing ataxia in the upper extremities.

Recommendation-Specific Supportive Text

1. An assistive or orthotic device may provide external support to increase stability and confidence during gait. Clinicians should provide the least restrictive device that will provide sufficient support but will not deter recovery of the paretic lower extremity. When a patient poststroke is provided with an assistive or orthotic device acutely, they should be re-evaluated throughout the course of recovery, as their need for external support may change.
2. Balance impairment is common poststroke and can result in low balance confidence, leading to activity restriction, further reducing mobility that can lead to secondary impairments of disuse atrophy and cardiovascular compromise. If balance impairments are left undetected or untreated, they can result in a cascade of serious, undesirable, and expensive events, including falls. Evaluation of balance abilities will help determine fall risk and guide the selection and tailoring of balance-specific interventions.[23–25]
3. Evidence for effective rehabilitation of poststroke ataxia is limited to case studies, both of which specifically examined recovery of upper limb ataxia.[2,3] Decreased impairment and functional gains were reported, suggesting benefit in these limited

cases. More research on approaches to treating poststroke ataxia (ie, efficacy of limb-weights) is warranted.[29]

4. Tai chi, as a form of physical activity, focuses on controlling the stability of movements and the speed of breath, and increasing peace of mind, addressing strength, flexibility, coordination, and balance.[30] Tai chi has been applied in stroke rehabilitation for more than 10 years worldwide.[31] During tai chi, the slow, rhythmic movements are connected in a continuous sequence, while body weight is shifted from one leg to the other.[32] This challenges the balance control system to keep its center within a changing base of support, and increases balance. Tai chi exercise has resulted in improved scores on standardized balance assessments. Tai chi requires no specialized equipment, it is often offered at a low cost, and movement sequences can be adapted to one's mobility level. This intervention can be accessed within the community, not requiring a hospital/clinic setting for implementation.
5. VR is an advanced computer-human interface with a variety of safe 3-dimensional environments in which patients can perform real-time tasks and anticipate and react to objects or events.[33–35] VR uses interactive simulations created to present users with the opportunity to participate in environments that simulate real-world situations and events in a safe environment. Advances in technology have made it possible to start using immersive VR as a therapeutic approach to improving motor function in patients with stroke. VR training is more effective than conventional therapy without VR in improving balance and gait ability in patients with stroke, both when VR interventions are added to conventional therapy and when time dose is matched. VR has also been shown to contribute to positive changes in cortical reorganization.[36] VR's observational learning capabilities can activate mirror neurons in the cortex.[37] Patients who experienced sensory feedback during the VR intervention were more likely to achieve the desired motor activity.[38] The feedback can boost use-dependent cortical plasticity development, resulting in improved motor control. Interactive video games can be considered a specific form of VR. There are numerous interactive commercial video game consoles available that have been used for the rehabilitation of individuals with neurologic impairment. Those that create an avatar from patients' anatomical landmarks and project the reproduced movements of the player on the game screen enable interaction without the need for a game controller,[39] which would be advantageous for persons poststroke with impaired grasp. Gaming-based interventions are creative and fun ways to exercise.[40] They provide repetitive, intensive, and task-oriented practice that, due to their engaging approach, may result in increased adherence to rehabilitation.[41] Gaming-based interventions have a smaller footprint than immersive VR. In some instances, once a patient is set up and instructed in the game, they may be able to engage independently or with only minimal supervision. These factors have the potential to reduce patient costs and save on labor.[42]
6. Impairments in trunk function are common poststroke[43,44] and correlate with decreased mobility, balance, and functional independence.[45,46] Poor mobility and balance are risk factors for falls poststroke[47] and decreased functional independence can contribute to lower perceived quality of life.[48] Trunk control and sitting balance are considered key predictors in functional outcome and hospital length of stay following stroke.[49] Decreased strength of the anterior, lateral, and posterior trunk musculature is a common contributor to impaired trunk function poststroke.[46] These muscles also exhibit delayed and asymmetrical activation, causing impairments in postural adjustments.[43] Trunk function is largely influenced by core stability — active muscular control of the lumbopelvic-hip regions. This requires specific co-contraction between key muscle groups, including the paraspinals, quadratus lumborum, abdominals, hip girdle musculature, pelvic floor, and diaphragm.[50] The core provides dynamic stabilization during whole-body movements.[51] This dynamic stabilization translates into adequate balance control during upright activities and gait.
7. Cardiorespiratory fitness and strength are both frequently impaired following stroke. Combining cardiorespiratory training (walking, ergometer-based) and strength training (body weight, elastic bands, free weights) could improve these impairments and are indeed common elements of a poststroke physical rehabilitation program. Although these types of training are not "balance-specific," evidence exists (albeit of low certainty) that this combined training may improve balance.[15]

Knowledge Gaps and Future Research

- Tai chi may benefit persons with stroke, but trials with longer-term follow-up periods are still needed. Future studies examining the effectiveness of tai chi as a fall prevention strategy for community-dwelling survivors of stroke are recommended.
- Long-term follow-up studies of individuals provided assistive or orthotic devices early after stroke are warranted to assess if early provision of external aids facilitates improved balance and decreased fall incidence.

- Interactive gaming-based interventions improve functional balance in poststroke individuals when compared with other, or absent, interventions, but they did not influence the mobility of individuals poststroke. Clinical studies with high methodological quality are needed to establish whether interactive video games result in mobility improvement for persons with stroke.
- Research regarding evidence-based interventions for the rehabilitation of poststroke ataxia is lacking.

5.5. Gait and Mobility

Recommendations for Gait and Mobility
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendation
1	A	1. For persons with stroke, an evidence-based, goal-oriented, multidisciplinary physical rehabilitation program is recommended to improve gait and mobility.[1–6]
1	A	2. For persons with stroke, task-specific training focused on overground walking, stepping, and balance is recommended to improve gait and mobility.[5,7,8]
2a	B-R	3. For persons with subacute or chronic stroke, moderate- to high-intensity stepping and/or high-intensity interval exercise focused on walking speed can be effective to improve walking endurance, walking speed, and balance.[2,3,7,9–13]
2a	A	4. For persons with stroke, resistance training of both the more- affected and less-affected legs, though not the less-affected leg alone, can be effective in improving walking endurance, balance, and mobility.[11,13–15]
2a	B-R	5. For persons with stroke, rhythmic auditory stimulation or cueing interventions can be effective in improving walking speed, balance, and gait spatiotemporal kinematics.[16,17]
2a	B-R	6. For persons with stroke, lower limb constraint-induced movement therapy (CIMT) can be effective in improving walking independence, walking endurance, balance, and mobility.[18–20]
2a	B-R	7. For persons with stroke, motor imagery or mirror therapy with bilateral movements can be effective to improve walking speed.[21,22]
2a	B-R	8. For persons with stroke, interactive gait training with *exergames or VR can be effective to improve walking speed, endurance, mobility, balance, and gait spatiotemporal kinematics.[6,23–25]
2a	B-R	9. For persons with stroke, at least 4– to 8 weeks of high-dose therapy (ie, 1–2 hour sessions, 5 times per week, with moderate to vigorous cardiovascular intensity, and increased stepping repetitions) can be effective at improving walking speed and walking endurance.[9,26,27]
2b	A	10. For persons with stroke, functional electrical stimulation (FES) of the affected leg combined with an exercise program may be considered as a restorative therapy for improving gait kinematics, walking endurance, balance, and mobility.[13,28–31]
2b	B-R	11. For persons with chronic stroke, water-based exercises may be considered to improve walking speed, balance, and mobility.[32,33]
2b	B-R	12. For persons with stroke, acupuncture in combination with rehabilitation may be considered for improving gait kinematics and balance.[34,35]
2b	B-R	13. For persons with stroke, somatosensory stimulation (below the motor threshold) using TENS of the affected leg may be considered to improve gait and mobility.[36]
2b	B-R	14. For persons with stroke, gait training with visual biofeedback may be considered to improve gait speed, balance, and mobility.[37]
2b	B-R	15. For persons with poststroke spasticity, medical treatment of spasticity may be considered to improve walking speed.[37–40]
3: No Benefit	A	16. For persons with stroke who are ambulatory, robot-assisted gait training (RAGT) is not recommended over task-specific overground gait training to improve walking and mobility.[41–44]
3: No Benefit	A	17. For persons with stroke who are ambulatory, light- to moderate-intensity gait training on a treadmill (with or without body-weight support) is not recommended over task-specific overground gait training to improve walking and mobility.[1,5,42,45,46]
3: No benefit	B-R	18. For persons with stroke, neurodevelopmental treatment approaches, such as Bobath, are not recommended to improve walking and mobility.[47–49]

*Exergames use interactive video games that combine physical exercise with gameplay elements to support the recovery or improvement of physical and cognitive functions in patients.

Synopsis

Restoring walking function is a top priority after stroke and a central goal of stroke neurorehabilitation. Effective walking interventions require a multidisciplinary, task-specific approach that promotes motor recovery and neuroplasticity. Early and continued gait training, from acute to chronic phases,[1,2,9,18] promote meaningful improvements in walking function, such as walking endurance (6-Minute Walk Test), walking speed (10-Meter Walk Test), mobility (Timed Up and Go Test), balance (Berg Balance Test), spatiotemporal kinematics (step length, cadence, symmetry, etc.), independent walking (Functional Ambulatory Category), and the ability to perform ADLs (Barthel Index). Evidence supports moderate- to high-intensity, task-specific locomotor training[2,7,9] and high-dose, repetitive practice.[27] Complementary strategies, such as resistance training,[14,15,50] FES,[28–30] rhythmic auditory cueing,[16,17,51] mirror therapy,[21] and VR,[27] may also enhance gait when targeted appropriately. Emerging strategies such as aquatic therapy,[32,33] lower extremity CIMT,[18] and visual biofeedback[37] show promise but require further study. Technologies such as RAGT[42,43,45] and treadmill-based interventions[5,42,45] offer comparable benefits to overground task-specific training yet may be costly and have accessibility challenges. Future research should aim to optimize dosage, identify responder profiles, and conduct large-scale, pragmatic trials to refine best practices for long-term walking recovery after stroke.

Recommendation-Specific Supportive Text

1. Gait rehabilitation following stroke involves a structured, multidisciplinary approach aimed at restoring mobility through targeted physical interventions. Contemporary gait training approaches integrate neuroplasticity-based therapies, which promote the brain's ability to reorganize and form new neural connections, with compensatory techniques that help individuals adapt to residual impairments. Existing evidence indicates that initiating walking interventions early in the recovery process leads to more rapid gains in walking compared with usual care.[1] Additionally, ongoing interventions into the chronic phase of stroke (≥6 months) also continue to yield functional improvements in walking.[2,9,18] Evidence supports the effectiveness of structured locomotor training, regardless of delivery method,[1,5,45] highlighting the importance of both intensity[3,4] and consistency.[25] Programs aligned with physical activity recommendations for individuals poststroke also show notable improvements in walking.[4,52] Despite these positive outcomes, gaps remain in determining optimal training dosage, frequency, and personalization of interventions across a heterogeneous population of individuals poststroke. Further research is needed to clarify how best to optimize, sustain, and enhance long-term gait recovery.
2. Task-specific training for stroke rehabilitation involves practicing functional activities such as overground walking, stepping, and balance tasks to directly target impaired gait and mobility. These exercises are designed to mimic real-world movements, promoting motor learning and improving walking ability through repetition and relevance. Overground walking interventions have been shown to improve walking independence and speed after 4 weeks of training[5,8] and are comparable in outcome to more expensive treadmill- or robot-based interventions.[5,45] Studies also indicate that task-specific overground training may be more effective than nonspecific exercises, such as seated aerobic training, in improving gait.[7] Incorporating functional resistance tools, such as resistance bands, during walking or stepping can also further enhance strength and walking performance.[15,50,53] While task-specific training is cost-effective and practical for broad implementation, additional research is warranted to optimize protocols for long-term functional recovery.
3. Moderate- to high-intensity locomotor training involves task-specific walking exercises performed at 40% to 60% (moderate) or >60% (high) of heart rate reserve (eg, target heart rate = [heart rate max − heart rate rest] × intensity + heart rate rest).[52,54] While heart rate reserve accounts for resting heart rate, which is often elevated in individuals poststroke and may therefore lead to under prescription of exercise intensity when not taken into account, the percentage of maximal heart rate can also be used to prescribe walking exercise. Specifically, 65% to 75% of maximal heart rate corresponds to moderate intensity, and values exceeding 75% correspond to high intensity. Maximal heart rate can be determined directly through a graded maximal exercise test or estimated using age-predicted equations such as the traditional formula [220 − age] or potentially more accurate equations for older adults [208 − 0.7(age)].[55] For individuals poststroke who are taking beta-blocker medications, equations that account for medication-induced attenuation of maximal heart rate should be used (eg, [164 − 0.7(age)][56] OR [119 + 0.5(resting heart rate) − 0.5(age) − (0, if training uses a treadmill; 5 if stationary bike)]).[57] In individuals with chronic stroke, high-intensity stepping[2] and interval-based protocols that push individuals to walk at or near their maximal walking capacity[9] have been shown to result in greater improvements in walking endurance (6-Minute Walk Test). However, if individuals are not able to reach high-intensity, moderate-intensity walking performed over 4 weeks during inpatient subacute rehabilitation also shows improvements in walking endurance.[3] Currently, these benefits are most consistently seen when the exercise is walking-specific (eg, treadmill or overground walking), rather than non–task-specific modalities such as recumbent cycling.[7] While high-intensity exercise may offer a time-efficient intervention to improve walking, current evidence has not established whether it reduces the total exercise time needed for each session (ie, 20 minutes versus 40 minutes) to achieve comparable improvements in walking function. Further studies are needed to address practical barriers such as cardiovascular risk safety screening, equipment needs, and pragmatic feasibility during inpatient and outpatient rehabilitation.

4. Resistance training involves exercises designed to improve muscular strength by working against a force or load. Evidence suggests that incorporating the less-affected leg during functional strength training contributes meaningfully to functional gains in walking and balance, highlighting the importance of a bilateral approach.[15] While current studies support the use of resistance training to improve functional outcomes, it remains unclear which method, whether resisted functional stepping using tools such as Thera-bands/weighted cuffs[15,50] or conventional gym-based weight machines,[14] is more effective.
5. Rhythmic auditory cueing uses external rhythmic stimuli, such as a metronome, music, or a combination of both, to guide and improve walking patterns in individuals recovering from stroke.[58,59] In those with subacute or chronic stroke, this intervention has been shown to enhance walking speed, balance, and the timing and coordination of gait movements.[16,17,51] Studies support its role in promoting more symmetrical and stable walking, likely by reinforcing consistent step timing and facilitating motor planning. However, there is limited clarity on how to adjust the stimulus, such as increasing tempo or intensity, as gait improves. Additionally, significant variability exists across studies in the type of auditory stimulus used. It remains unclear whether pure metronome beats, music, auditory devices, or a combination provide the most benefit, leading to inconsistency in clinical approaches.[17] Further research is needed to determine optimal cueing strategies and how to tailor them over time.
6. CIMT for the lower limb involves intensive, task-specific training of the affected leg, often paired with strategies to limit compensation by the less-affected limb. In individuals poststroke, this approach has demonstrated improvements in walking independence, endurance, balance, overall mobility, and the ability to carry out daily activities.[19] Functional gains have been observed even in protocols that exclude physical restraint of the less-affected leg, suggesting that focused, high-repetition practice alone may drive recovery.[2] However, some studies using physical restraint, such as ankle weights or joint immobilization, have also reported positive outcomes,[19] creating uncertainty as to whether the restraint itself is necessary or if benefits stem primarily from the high dose of task-oriented training. This raises important questions about the role of restraint versus intensity and whether CIMT is distinct from other forms of high-intensity therapy. Further research is needed to clarify the mechanisms behind CIMT's effectiveness and to determine whether restraint enhances or hinders recovery.
7. Motor imagery and mirror therapy are cognitive and visual-based interventions that aim to activate motor pathways without actual movement. Motor imagery involves mentally rehearsing a movement, while mirror therapy uses the reflection of the less-affected limb to create the illusion of movement in the more-affected limb — often incorporating elements of motor imagery. In individuals recovering from subacute stroke, both approaches have been shown to improve walking speed, particularly when introduced early and during bilateral limb movements rather than unilateral exercises.[21] Current protocols typically involve open-chain exercises, such as ankle dorsiflexion or knee extensions, limiting their application to weight-bearing tasks. Additionally, combining mirror therapy with electrical stimulation appears to further enhance gait speed, though it remains unclear whether this combination is superior to mirror therapy alone. There is a need for research on the feasibility and effectiveness of integrating these therapies into closed-chain, weight-bearing tasks such as walking, which would better reflect functional demands.
8. VR and exergaming are technology-based interventions that use interactive, computer-generated environments to promote physical activity and motor learning. VR typically offers immersive or semiimmersive environments with visual and auditory feedback, while exergaming uses motion-sensing technology and game-like tasks to encourage movement. In individuals with subacute or chronic stroke, these interventions have demonstrated improvements in walking speed,[24] endurance,[6] balance,[6] mobility,[25] and gait kinematics.[24] Programs vary in task specificity, with some focusing on walking-related tasks such as stepping and weight shifting, while others involve general lower-limb movements without simulating functional walking. Evidence suggests that interventions incorporating gait-specific tasks may yield greater improvements in walking outcomes; however, differences in technology, task design, and level of immersion across studies make it difficult to determine which approach is most effective. Further research is needed to clarify how task specificity and platform type influence recovery to directly compare the benefits of VR and exergaming.
9. High-dose locomotor training involves frequent, intensive walking-based therapy, focused on maximizing repetitions, to promote neuroplasticity for improvements in gait in individuals after stroke. Evidence supports the effectiveness of high-dose locomotor training in improving walking speed and endurance for individuals in both the subacute[27] and chronic stages[9] of recovery. Retrospective analyses also suggest that ≈30 sessions of

walking may be required to achieve clinically meaningful improvements.[26] Although high-dose locomotor training encompasses multiple elements of exercise prescription, including increased repetitions, frequency, and overall volume, dose alone is insufficient to drive functional improvements in the absence of adequate training intensity. Prior clinical trials indicate that meaningful improvements in locomotor function require the inclusion of moderate-to-vigorous intensity, reflecting not only cardiovascular demand but also the task-specific neuromuscular and biomechanical challenge necessary to stimulate locomotor-specific adaptations.[60,61] Despite consistent support for its benefits, questions remain regarding how the optimal training parameters may vary across impairment levels.

10. FES involves the use of exogenous electrical currents to activate specific muscles during functional tasks such as walking. When used in stroke rehabilitation as a restorative therapy, FES is often combined with exercise programs to activate and strengthen muscles, leading to improved gait kinematics,[28] endurance,[29] balance,[30] and overall mobility.[28,30] However, the evidence remains mixed when using FES as a restorative intervention to improve walking function (when assessed without stimulation), with some trials showing benefits over usual care and others finding limited or no added effect. Variability in outcomes may be due in part to differences in stimulation sites, such as peroneal nerve versus multimuscle stimulation, which introduces heterogeneity across studies. The optimal location, timing, and combination of stimulation remain unclear, and further research is needed to standardize protocols and clarify which patients are most likely to benefit from FES. Additionally, assistive FES applied during walking assessments to cue muscle activation during the gait cycle may produce functional gains comparable to those achieved with an ankle-foot orthosis (AFO) walking intervention.[31] For additional AFO-specific recommendations, please see section 5.7 "Adaptive Equipment, Durable Medical Devices, Orthotics, and Wheelchairs."
11. Aquatic therapy involves performing exercises in a water-based environment, with buoyancy offloading weight-bearing activities while hydrostatic pressure applies resistance to movements from all directions, to aid physical rehabilitation. For individuals with chronic stroke, this intervention may offer benefits in improving walking speed,[32,33] balance,[32,33] and overall mobility[32] compared with traditional land-based therapy. Practical challenges like the time required for preparation, cost of equipment, and potential risks for individuals with certain medical conditions (eg, percutaneous endoscopic gastrostomy [PEG] tubes or surgical incisions) may limit widespread implementation. Further research is needed to determine the long-term effectiveness of aquatic therapy and to clarify which patient populations benefit most.
12. Acupuncture is a therapeutic technique involving the insertion of fine needles into specific body points to promote healing and functional recovery. In individuals with subacute or chronic stroke, when acupuncture is used in conjunction with conventional rehabilitation, it has shown potential to enhance gait kinematics[35] and balance.[34] Emerging evidence supports its use as a complementary approach, suggesting additive benefits beyond standard therapy alone. However, the specific mechanisms of driving improvement remain unclear. Key knowledge gaps include the comparative effectiveness of acupuncture with and without electrical stimulation, as well as how it differs from dry needling in stroke populations.
13. TENS is a noninvasive technique that delivers low-intensity electrical currents through the skin to stimulate sensory nerves. In individuals recovering from stroke, applying TENS to the affected leg has shown potential to enhance gait and mobility[36] when integrated into rehabilitation programs. Evidence suggests that somatosensory-level stimulation, which does not activate muscle contractions, may positively influence motor recovery by enhancing sensory input to the central nervous system. However, there is significant variability in stimulation sites and protocols across studies, making it difficult to determine optimal application methods. Further research is needed to establish standardized parameters and clarify which stimulation sites yield the most consistent functional improvements.
14. Visual biofeedback is a rehabilitation technique that provides real-time visual cues to help persons with stroke adjust and improve their movements during gait training. In people with subacute or chronic stroke, integrating visual feedback into treadmill gait training, such as showing foot placement, has been associated with greater improvements in walking speed compared with treadmill walking alone.[37] Additionally, combining visual and auditory biofeedback through interactive VR gaming has been shown to enhance balance and mobility.[62] Beyond visual input, other forms of biofeedback, such as force output, movement velocity, or signals from neuromotor activity (EMG or electroencephalography), may offer additional therapeutic value, though their specific impact on gait recovery remains underexplored. Further research is needed to determine which biofeedback modalities are most effective.

15. For individuals experiencing spasticity after stroke, certain medications may support walking-related outcomes. Intrathecal baclofen has shown potential to enhance walking speed[38] by reducing severe spasticity. While the evidence is unclear whether botulinum toxin injections may directly improve walking speed,[39,40] Botox may alleviate muscle stiffness and pain, which may indirectly support mobility and comfort during walking. Further research is needed to determine optimal spasticity management strategies and to clarify how much tone is necessary for effective walking in persons with stroke. For additional information regarding poststroke spasticity management, please see section 5.3, "Management of Spasticity." There is also a limited understanding of how commonly prescribed medications, such as SSRIs (including fluoxetine), may affect walking outcomes. While these medications have been studied in the context of upper limb and general functional recovery, evidence for their role in gait recovery remains limited.
16. RAGT involves the use of devices, such as exoskeletons, end-effector systems, or treadmill-based platforms, to support and guide lower limb movement during walking practice. In persons with stroke who are ambulatory, RAGT has shown similar outcomes in walking speed and mobility compared with conventional, task-specific overground gait training.[41–44] Despite technological sophistication, the high cost of robotic devices and the time required for setup may limit their practicality in routine clinical settings. While upper extremity robotic therapy may offer cost advantages,[63] comparable data for lower limb applications are lacking. RAGT may still hold value in reducing physical strain and burnout for rehabilitation professionals during high-repetition gait training. However, evidence remains limited for its use in individuals who are nonambulatory or in protocols using end-effector systems.[42] Further research is needed to determine cost-effectiveness and clinical benefit in more dependent stroke populations.
17. Treadmill gait training involves walking practice on a moving belt, often with optional body-weight support via a harness system. For individuals with subacute or chronic stroke who are already ambulatory, light to moderate intensity treadmill gait training has shown outcomes comparable to task-specific overground gait training in improving walking and mobility.[5,41,42] Overground walking may offer better task specificity, while treadmill systems can be expensive and less accessible. However, there is limited evidence regarding the benefits of using treadmill gait training for high-intensity exercise, including whether self-selected or clinician-controlled speeds produce superior walking outcomes. Treadmills may also be useful in space-limited settings and may lessen the physical load on clinicians, especially when assisting more dependent ambulators. Body-weight support systems may also enable clinicians to facilitate lower limb clearance during gait practice without requiring additional staff. Harness-and-catch systems (with or without using body-weight support) can also provide a safe environment by reducing the risk of falls.
18. Neurodevelopmental therapy (NDT), including approaches such as the Bobath and proprioceptive neuromuscular facilitation, focuses on facilitating normal movement patterns through guided handling and postural control techniques.[64–66] Evidence supporting proprioceptive neuromuscular facilitation remains limited and of low quality, making it difficult to assess its true effectiveness in stroke populations. Bobath interventions have not demonstrated superior outcomes in walking or mobility when compared with other evidence-based interventions[47] such as task-specific gait training,[48,49] and this aligns with the APTA's Academy of Neurologic Physical Therapy recommendation to move away from its clinical use.[67]

Knowledge Gaps and Future Research

- Current evidence for most walking interventions is limited to phase 1 randomized controlled clinical trials. Larger, well-designed phase 2 and 3 multisite clinical trials with walking function as the primary outcome are needed to determine effectiveness compared with usual care or conventional therapy. Rigorous pragmatic studies with standardized protocols and diverse populations will help clarify clinical utility and guide future walking and mobility recommendations for individuals across all stages of stroke recovery. Additionally, future clinical trials should incorporate not only laboratory-based assessments of walking function but also measures of real-world community ambulation such as steps per day. Due to the challenges of conducting large-scale clinical trials during the acute and subacute stages of stroke, many interventions discussed within this section were based on research performed within the chronic stage. Although it is often assumed that therapeutic interventions effective for improving walking function in the chronic stage may yield similar or greater benefits when applied earlier after stroke, this assumption has not been conclusively established. Therefore, there is a strong need for future RCTs to be initiated as early as safely feasible and to continue across the full continuum of poststroke care. However, it is imperative that such trials be planned and designed with utmost care to ensure that the study is adequately

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powered and that groups are well balanced in baseline characteristics and recovery potential, so that differences in spontaneous biological recovery between groups do not confound the results.[68]

- Additionally, many up-and-coming interventions with limited evidence include:
  - Split-belt treadmill: Split-belt treadmill training uses belts moving at different speeds to address gait asymmetries poststroke. Preliminary studies show pre-post improvements in walking speed and step length, especially in higher-functioning individuals. However, its effectiveness over conventional gait training remains uncertain, highlighting the need for larger controlled trials.[69–71]
  - Noninvasive neuromodulation: Noninvasive neuromodulation uses brain stimulation techniques to influence motor recovery after stroke. High-frequency rTMS to the ipsilesional hemisphere, combined with gait training, may improve walking speed.[72–74] While rTMS demonstrates promising preliminary evidence for improving walking outcomes, these effects are likely attributable to the specific stimulation protocol, as other neuromodulation methods, such as tDCS or theta burst stimulation, show limited or no benefits over sham stimulation.[75,76] Effectiveness, especially for mobility, remains unclear and requires further investigation. However, it is to be noted that most of the neuromodulatory techniques are currently not approved by the FDA and are considered investigational devices.
  - Tai chi/qigong: Tai chi and qigong are mind-body exercises combining slow, controlled movements with breathing and balance training. Comparative effectiveness with conventional therapies warrants further high-quality, controlled research.
  - Ischemic conditioning: Ischemic conditioning involves brief, repeated cycles of restricted blood flow to the paretic leg of individuals poststroke to improve blood flow to the distant skeletal muscle. Early evidence suggests potential improvements in walking speed in individuals with chronic stroke[77]; however, the effectiveness of ischemic conditioning compared with standard rehabilitation remains unclear, requiring further large-scale, controlled trials.
  - Multimodal interventions: Multimodal interventions combine 2 or more technologies, such as neuromodulation, robotics, and VR, to enhance stroke rehabilitation for additive benefits. However, variability in protocols and limited comparative data make it difficult to identify which combinations are most effective, highlighting the need for further controlled research.

5.6. Upper Extremity Activity, Including ADLs, IADLs, Touch, and Proprioception

Recommendations for Upper Extremity Activity, Including ADLs, IADLs, Touch, and Proprioception
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-R	1. In persons with poststroke hemiparesis, ADL training tailored to individual needs and eventual discharge setting is useful to achieve an optimal level of independence.[1,2]
1	B-NR	2. Persons with stroke should receive instrumental ADL (IADL) training tailored to individual needs and eventual discharge setting for optimal function.[1,2]
1	A	3. In persons with stroke, repetitive, progressively graded practice of functional tasks, including through task-specific training approaches such as CIMT and its modified versions, is recommended to improve ADL performance and motor function.[3–6]
2a	A	4. For persons living with moderate to severe upper limb hemiparesis, it is reasonable to consider robotic-aided rehabilitation in addition to standard treatments to deliver a higher dose of practice and to improve motor function.[7–9]
2a	A	5. In persons with minimal volitional movement or with shoulder subluxation within the first few months after stroke, it is reasonable to consider NMES to reduce subluxation and improve arm positioning.[10–12]
2b	B-R	6. For persons with chronic moderate to severe impairment of the distal upper limb, it may be reasonable to consider NMES for improvement in motor impairment and functional activities.[13–15]
2a	B-R	7. In persons with upper limb hemiparesis after stroke, it is reasonable to consider mental practice as an adjunct to other upper extremity rehabilitation therapies to improve motor skills.[16,17]
2a	B-R	8. In persons with upper limb hemiparesis after stroke, it is reasonable to consider strength training as an adjunct to functional task practice.[18]
2a	B-R	9. In persons with upper limb hemiparesis, it is reasonable to consider VR as a method to deliver additional upper extremity practice to improve motor skills[19]
2a	B-R	10. For persons >6 weeks poststroke with mild to severe upper limb hemiparesis, it is reasonable to consider active somatosensory discrimination training for improving sensory discrimination function, hand function, and daily arm use.[20–23]
2a	B-R	11. In persons with stroke and moderate to severe upper limb hemiparesis, it is reasonable to use mirror therapy to improve motor function and ADLs.[24–34]
2b	B-R	12. In persons with stroke and upper limb hemiparesis, it may be reasonable to combine somatosensory stimulation or priming with task-specific training or CIMT to improve sensory and motor skills.[35–39]

Recommendations for Upper Extremity Activity, Including ADLs, IADLs, Touch, and Proprioception (Continued)

COR	LOE	Recommendations
2a	B-R	13. In persons with stroke and moderate to severe upper limb hemiparesis, bilateral training paradigms can be useful to improve motor function and ADLs.[40,41]
2b	B-R	14. For eligible persons with stroke and upper limb hemiparesis, vagus nerve stimulation (VNS) paired with high-dose task-specific training may be considered to improve upper limb function and impairment[42–46]
3: No Benefit	B-R	15. For persons with stroke and hemiparesis, neurodevelopmental training (Bobath technique) is not recommended for improving motor skills and strength of the upper limb.[47,48]

Synopsis

Upper extremity hemiparesis is one of the most common poststroke disabilities. However, recent data suggest that the prevalence of upper limb weakness within the first week after stroke is declining compared with previous reports from the 1990s[49] and is estimated at between 48% and 57%.[50] It is important to understand that the accuracy of population-level upper limb weakness prevalence reports can be affected by various entities, including the specific measurement tool, the score cutoff, days poststroke, characteristics of the sample, and the number of sites.[50] The decrease in prevalence of hemiparesis could be due to improvement in medical procedures in the acute phase.[51]

Many individuals with early upper limb impairment may still have limited functional use of their affected arm 6 months later. Loss of ability to use the upper limb can negatively affect independence in ADLs as well as performance in life roles (work, childcare, community activities).[2] Due to the persistence of upper limb impairment poststroke, various techniques have been reported in the literature.[5,19,33,44,47,52–54]

Recommendation-Specific Supportive Text

1. Individuals living with stroke may have trouble performing everyday activities because of physical or cognitive challenges caused by the incident. As a result, they often need long-term care, which can include help from family and friends, paid caregivers, assisted living, and nursing homes.[1] This care is often expensive, and financial obligations may be considerable. Occupational therapy helps persons with stroke improve their ability to do daily tasks and become as independent as possible, thus minimizing caregiver burden.[1] Training in ADLs is implemented continuously to allow for ongoing evaluation.[55] ADLs are graded with increasing challenge to develop skills and maximize performance. Treatment can be focused on remediation of capacities, or occupational therapists can use a compensatory approach. Examples of compensatory approaches include adaptive equipment (such as a built-up grip for improving self-feeding) or environmental adaptations. An example of the latter is a walk-in shower to allow bathing to be more accessible.[1]
2. In addition to providing training for self-care activities, occupational therapists also work with individuals living with stroke on IADLs. IADLs are needed for independence in the home as well as the community and include tasks such as cooking, home-making, shopping, driving, finances, and work activities. IADLs are more complex tasks, and, thus, comparing treatment approaches in research is not straightforward.[2] IADLs can be used therapeutically to improve motor and cognitive skills. They are also practiced as goals to reach a greater level of self-sufficiency. Typically, IADL interventions are intentionally focused on specific activities that adults with stroke value and want or need to perform. Tasks are tailored to the individual's skill level, abilities, intentions, and interests.[1,55]
3. Task-specific training or repetitive task training[6] has become a standard-of-care intervention in many stroke rehabilitation facilities. It focuses on repetitive practice of specific real-life functional tasks, including grasping and manipulating objects using the upper limb. Elements of task-specific training include goal identification, object-oriented actions, specific feedback, a structured practice schedule, learning transfer through variable and blocked practice, knowledge of performance, and the incorporation of unimanual and/or bimanual functional tasks.[6,54] Task-specific training is a major element of other upper limb interventions such as constraint-induced movement therapy (CIMT),[3–5] as well somatosensory stimulation,[35,36,38,56–58] FES,[15,59–61] and NMES.[14,62] Both CIMT and its modified version (mCIMT) are appropriate for individuals with mild upper limb hemiparesis and active wrist and finger extension. CIMT uses object-oriented tasks, shaping of activities, and task modification during unimanual task practice. Despite discrepancies in the dosage and implementation of mCIMT, meta-analyses consistently indicate that both the original and modified forms of CIMT yield substantial and clinically meaningful improvements.[3,4] CIMT is considered one of the most effective interventions for improving function in the upper limb after stroke.[3,4]
4. Individuals with severe paresis have fewer treatment possibilities for upper limb recovery. Robotic therapy is appropriate for individuals with severe to moderate hemiparesis, and studies using various robots to provide therapy for persons with stroke are plentiful.[7–9,63,64] In a comparison study using upper limb training in occupational therapy as an active comparison group, Lin et al found that robotics was not

inferior or superior to dose-matched upper limb occupational therapy.[8] A meta-analysis found that individuals who were in robotic therapy groups made small improvements in motor impairment, upper limb function, and ADLs.[63] The authors emphasize that the difference in improvements may be due to a greater number of repetitions in the robotic group. A 3-arm trial comparing robotic therapy, enhanced upper limb training, and standard care demonstrated that while the robotic group showed improvements in motor impairment, these gains did not translate into improved performance of ADLs.[65] The latter finding was consistent with a systematic review and meta-analysis that concluded that the next generation of upper limb robot training should be driven by clearer insight into how motor learning interacts with post-stroke recovery.[66] In summary, superiority of robotic therapy has not been demonstrated. However, it can provide additional benefit as it creates more possibilities for motor practice.[63] Adverse events are uncommon, making robotic therapy a safe option for practice without the presence of a therapist.

5. NMES can be incorporated into a treatment plan for individuals who lack voluntary movement. Upper limb muscles that are targeted during NMES vary depending on the purpose. NMES can be used to reduce subluxation,[10] increase distal movement,[13] provide facilitation for individuals with severe upper limb impairment[52] or to target multiple muscles.[67] The use of NMES to reduce shoulder subluxation has demonstrated effectiveness.[10,68]
6. Likewise, studies using NMES have demonstrated improvement in ADLs.[10,15] A systematic review and meta-analysis with a large number of participants from various trials (N=617) found that EMG-NMES is a good option to improve upper limb motor impairment in the short term in individuals with severe or moderate upper limb hemiparesis in the chronic phase of recovery.[13]
7. There is also evidence that mental practice may be beneficial as an adjunct to physical practice, especially when the latter is difficult. A systematic review provided moderate-certainty evidence that mental practice, when added to another physical rehabilitation treatment, produced improved outcomes compared with use of the other rehabilitation treatment alone. Evidence to date shows improvements in arm function and arm movement.[17] Stockley and colleagues found that mental practice was most efficacious during the subacute poststroke phase.[16] More research needs to be completed to assess the benefits and optimal dosage of mental practice paradigms.
8. Task-specific training is sometimes combined with strength training to increase efficacy. A combination of strengthening and task-specific training can be accomplished by adding resistance to the actual training tasks,[69] providing both strength training and task-specific training side by side,[18] or adding strengthening to a home exercise program.[54] A network meta-analysis found strengthening to be one of the most effective treatments for upper limb hemiparesis.[62]
9. Virtual reality and video gaming may improve patient engagement and motivation.[70] Studies showing the efficacy of these techniques on motor recovery, however, are not conclusive, as a large clinical trial using a VR treatment did not show superiority to a recreational therapy program.[71] A systematic review did find that VR therapy had a very small beneficial effect over other therapies (typically exercise). When VR was used to augment usual care, gains appear to be clinically relevant, with analyses showing small to moderate effect sizes.[19] Thus, VR and video gaming may be valuable interventions to deliver additional motor practice, especially outside of therapy.
10. Active somatosensory retraining programs focus on learning-based approaches to build skill in sensory discrimination after stroke. Studies have demonstrated the significant impact of attentive engagement with sensory stimuli in individuals who have persistent somatosensory deficits, including improvement of the ability to discriminate textures, recognize objects by touch, and perceive limb position with vision occluded.[20,21,72] Reacquisition of sensory function necessitates repeated practice, progression through graded levels of difficulty, and sustained attention to the sensory characteristics of tasks and objects. The clinician must offer performance-based feedback and incorporate the strategic use of vision and the less affected hand into the sensory training.[2120] There is some evidence that active somatosensory training increases the use of the affected limb.[73] Active somatosensory training has been successful in both the late subacute phase (3–6 months poststroke)[21] and the chronic phase.[20,21,74] However, in a multisite randomized trial of inpatients <8 weeks poststroke, a mixture of sensory training and motor tasks, did not show a positive effect.[75] The authors speculated the tasks in the experimental protocol required attention to both somatosensory and motor elements, which resulted in reduced attentional resources and degraded performance.
11. Mirror therapy is another possible treatment for individuals with moderate to severe upper limb impairment. Mirror therapy requires that the individual view their less-affected hand in a mirror positioned along the sagittal plane, creating the illusion that it is the affected hand. The technique is similar to the ventriloquist effect where the brain accepts the visual input as true. The efficacy of mirror therapy as a treatment technique has been documented[24–29,31–33,76,77]

Various forms of mirror therapy include task-specific mirror therapy (practice of actual tasks using mirror feedback),[24,78] mirror therapy using either video or VR,[27,30,32] mirror therapy using simple unimanual exercises or bilateral movements,[26,33] and mirror therapy with electrical stimulation.[34] Mirror therapy is often delivered alongside other interventions for the upper limb[25,31] and can also be performed in the home for extra practice.[29]

12. A cross-sectional study indicated that 57% of individuals with upper limb impairment have somatosensory deficits.[79] Given the high prevalence of impairment, interventions targeting the sensory system may improve the quality of upper limb rehabilitation. Somatosensory training includes 2 basic paradigms: active and passive. The latter includes stimulation methods such as thermal stimulation, deep pressure, PNS, TENS, and vibration stimulation.[80] The most well-studied passive sensory stimulation technique is somatosensory or transcutaneous electrical stimulation. Somatosensory stimulation is delivered below motor threshold and well above sensory threshold, with an intent to stimulate the sensory afferents. The stimulation technique is typically used prior to task-specific training, and the overall purpose is to improve sensory and motor skills poststroke.[35,38,57,58,80,81] Transcutaneous electrical sensory stimulation may not be as commonly used as NMES in clinical settings. It does have evidence of facilitating neuroplastic changes.[82–88]
13. Bilateral upper limb training, where both arms move in temporal and spatial synergy, has been studied in the literature. There is evidence that bilateral training may be efficacious for individuals with moderate to severe hemiparesis. Qian et al did find that, in the subacute phase, bilateral training was superior to unilateral in shoulder and wrist ROM measures. The trial was limited by a small sample size.[41] McCombe Waller et al[40] showed that, compared with unilateral training alone, a combination of bilateral training and unilateral training may be an optimal way to provide treatment for individuals with moderate to severe upper limb hemiparesis. An interesting combinatory bilateral training treatment paradigm is contralaterally controlled FES, which combines both symmetrical bilateral movement with FES as well as task-specific training.[59,61,89] In a multisite, 3-arm, randomized clinical trial, this combination of interventions demonstrated superiority in remediating motor impairment compared with cyclic NMES plus task-oriented training. It also demonstrated greater improvement in upper limb function compared with task-oriented training alone.[60] Evidence from a systematic review found equivalence in bilateral and unilateral training.[90] The review suggested, however, that bilateral training may be superior for limb strength and movement quality, while unilateral training may be better for general functional arm use during ADLs.[90]
14. VNS paired with intensive task-specific training is a promising development in upper limb poststroke rehabilitation.[42–46,91] The technique requires implantation of a device followed by an intense schedule of task-specific training in the clinic. After clinical practice is complete, additional practice at home follows. A study of the long-term effects of VNS found that individuals had a clinically significant change in the Fugl-Meyer assessment of upper extremities score at approximately 1 year postimplantation. Due to the crossover design, however, a comparison with the group who had sham VNS plus task-specific training was not possible.[46] VNS has been shown to be safe,[45] and more studies are needed to confirm the efficacy of VNS combined with task-specific training.
15. The use of NDT, also known as the Bobath technique, is not recommended.[47] Although Bobath training is still somewhat popular among rehabilitation therapists, no strong evidence describing the effectiveness of NDT in comparison with other upper limb techniques has been identified.[48] Therefore, we cannot recommend NDT as a treatment for poststroke upper limb hemiparesis.

Knowledge Gaps and Future Research

- Acupuncture has been used to improve upper limb hemiparesis. There are various forms of acupuncture for upper limb improvement, including auricular,[92] transcutaneous electrical acupoint stimulation,[53] conventional acupuncture,[93] and contemporary acupuncture.[93] A Cochrane systematic review found that due to the number of acupuncture techniques and acupoints, the number and duration of sessions, and the various intervention timelines, the evidence was of low quality. There was some evidence suggesting that acupuncture may improve ADLs and certain aspects of neurological function. Still, these conclusions are based on studies with low-quality evidence.[93] No serious side effects and few adverse events were reported in the reviewed acupuncture studies. Although acupuncture cannot be recommended for routine use, it is safe. Further research using high-quality designs is encouraged.
- Action observation therapy (AOT) consists of watching a film of an action followed by performance of the same action. A systematic review and meta-analysis found that AOT showed significantly improved upper limb motor function immediately after intervention, with a small effect size of 0.35.[94] A more recent review found low-certainty evidence that AOT may improve arm motor function of poststroke patients

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compared with a control group. Although AOT was shown to improve hand function, the results of the analyzed studies were not clinically meaningful.[95] Better-quality studies are needed.
- Previous studies have examined whether fluoxetine can improve a variety of poststroke functional outcomes. In a pragmatic multicenter clinical trial (FOCUS trial), it was determined that patients allocated to fluoxetine were less likely than those allocated to placebo to develop new depression by 6 months, but there was no between-group difference in functional outcomes as measured by the mRS.[96] The FLAME study did investigate upper limb motor outcomes in moderate to severely impaired individuals living with stroke. Chollet and colleagues found that early treatment with fluoxetine combined with physiotherapy improved motor recovery (as measured by the Fugl-Meyer) 3 months post–ischemic stroke.[97] These findings suggest that using medications to influence the brain's natural plasticity may offer a valuable therapeutic approach for acute poststroke patients.[97] In 2020, however, a double-blind safety and efficacy trial (AFFINITY trial) found that 20 mg of fluoxetine daily for 6 months after acute stroke did not improve functional outcome and increased the risk of falls, bone fractures, and epileptic seizures.[98] A large Cochrane review found mixed evidence that SSRIs may aid stroke recovery. Positive findings were not found in the trials with a low risk of bias.[99] Comparative studies are needed to determine the effectiveness of fluoxetine plus motor training on outcomes.
- ADL performance is a key element of stroke rehabilitation, and documentation of its efficacy is essential. Legg et al found low-quality evidence that ADL training by occupational therapists after stroke can improve ADL performance. The authors reported that studies had "methodological flaws," including less than adequate blinding.[1]
- Legg et al do acknowledge that blinding is nearly impossible, given the type of intervention (ADL training). An alternative design, such as practice-based evidence, may be more appropriate for an intervention (eg, ADL training) that is not experimental and is frequently used in the clinic. Practice-based evidence collects data from actual clinical environments, often using observational methods and statistical associations, and can identify best practices for specific types of patients. Rehabilitation researchers are urged to prioritize rigorous studies on real-world ADL interventions and outcomes, generating the evidence needed to support ongoing insurance reimbursement and to advance best practices in stroke rehabilitation.[100,101]
- There is a need for dosing studies on upper extremity interventions.
- There is a need for clinically informed development and premarket testing of tech-based interventions for motor practice and motor recovery.

5.7. Adaptive Equipment, Durable Medical Devices, Orthotics, and Wheelchairs

Recommendations for Adaptive Equipment, Durable Medical Devices, Orthotics and Wheelchairs
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-NR	1. In persons with stroke who have activity limitations or participation restrictions, adaptive and AD should be used to improve engagement in activities and participation.[1,2]
1	B-NR	2. In persons with stroke who have gait or balance impairments, ambulatory AD (eg, cane, walker) should be used to improve mobility efficiency and safety as needed.[3–6]
1	C-LD	3. In persons with stroke who are nonambulatory or have limited walking ability, wheelchairs should be used to support household and community mobility.[7–11]
1	A	4. In persons with poststroke hemiplegia, using an AFO or FES is recommended to improve balance and mobility.[12–19]
2b	B-NR	5. In persons with chronic stroke who have moderate to severe limitations in upper limb capacity, the use of static orthotics is not well established to reduce spasticity or improve hand function.[20,21]

Synopsis

Many persons with stroke require the use of adaptive equipment, AD, orthoses, and mobility aids to perform activities and increase participation.[1–4,12,22,23] A variety of adaptive devices and equipment are available. The appropriateness of a particular item will depend on the unique needs of the stroke survivor, including the type and level of functional deficits, degree of adaptation needed, structural characteristics of the living and treatment environments, and financial resources.[1,23]

Sensorimotor deficits after stroke often lead to gait impairments that impact functional mobility and may lead to an increased risk of falls (see sections 5.5, "Gait and Mobility" and 3.6, "Prevention of Falls"), necessitating the need for mobility devices (ie, canes, walkers, or wheelchairs) to enhance mobility.[1,3–11] Lower limb motor impairments, such as decreased dorsiflexion of the ankle, are often addressed through the use of an orthotic device, most commonly an AFO or the application of FES. Both methods improve balance, gait speed, and functional mobility.[4,12–16,18]

Upper limb impairments that impact engagement in activity are a common consequence of stroke. In chronic persons with stroke with moderate to severe impairments of the upper limb, the use of static orthoses to reduce spasticity or improve hand function is not well established.[20,21]

Recommendation-Specific Supportive Text

1. A variety of adaptive and AD are available, including equipment to make eating, bathing, grooming, and dressing easier for patients with functional limitations. Examples of AD include (but are not limited to) eating utensils with built-up handles, rocker knives, plate guards, nonskid placemats, long-handled sponges, handheld showers, tub and shower chairs, grab bars for bathrooms, and elevated toilet seats, commodes, or toilet frames. In a study investigating AD use after stroke, in addition to mobility devices, common AD uses included: shower seat (47%), toilet seat (27%), toilet safety frame (22%), commode (16%), pick up stick (15%), and kitchen stool (14%). Persons with stroke using the equipment reported feeling a lot safer (85.8%), more confident (78%), and more in control of day-to-day activities (74%), and stated that the equipment allowed them to take part in activities that they enjoyed (52%).[1]

   A meta-analysis found that occupational therapy for people with stroke improved their ability to carry out daily activities (standardized mean difference, 0.17 [95% CI, 0.03–0.31]; P=0.02) and reduced the risk of poor outcome (death, deterioration or dependency in personal ADLs) (OR, 0.71 [95% CI, 0.52–0.96]; P=0.03); although, the quality of the evidence was low. The protocols in most of the included studies focused on improving ADLs, including the provision and training in the use of AD.[2]

2. More than half of persons with stroke require an AD (cane, walker, wheelchair) to assist mobility, most frequently a cane.[3] Studies that have assessed the immediate effects of different AD provided in random order have shown that ambulatory function (speed, step length, functional ambulation category) was improved with a cane after stroke.[5,6] Patients felt that their walking, walking confidence, and walking safety improved and said that they would rather walk with an AD than delay walking to achieve a normal gait pattern.[6]

   However, the effect of the provision of a cane on walking ability may depend on the person with stroke's baseline gait speed. Nascimento et al found that a cane improved the walking speed and step length of slow walkers (<0.4 m/s) but provided the most benefit to the subgroup of intermediate walkers (0.4–0.8 m/s) in community-dwelling persons with chronic stroke. Importantly, provision of a cane decreased the speed of fast walkers (>0.8 m/s).[4]

   Walking devices increase the base of support around a patient's center of gravity and reduce the balance and effort needed to walk. Common walking aids include (but are not limited to) the following: single-point canes, tripod and quad canes, 2-wheeled and 4-wheeled walkers or rollators (4-wheeled walker with a seat).

3. For persons with stroke who cannot ambulate safely, a wheelchair can enhance mobility. Up to 40% of patients with stroke have been reported to use a manual wheelchair at rehabilitation discharge.[9] A wheelchair may be required when a patient is unable to ambulate or when there is concern about the patient's ability to ambulate safely or functionally.[24] The patient often propels the chair by using the less-affected hand on 1 wheel, with a foot on the floor. Self-propulsion in a wheelchair early after a stroke has not been shown to be detrimental to muscle tone or functional outcomes.[8] Many persons with stroke also use manual wheelchairs for longer-distance travel such as shopping or physician appointments, though they are capable of short-distance ambulation within the home. In these situations, the wheelchair is typically propelled by a caregiver.

   Although powered wheelchairs are less commonly used after stroke, many stroke patients can learn to use powered wheelchairs safely with appropriate training.[9] Wheelchair designs vary greatly, and a wheelchair prescription should be specific to the patient's needs and environment and patient and family/caregiver preferences. The prescription of a wheelchair (manual or powered) in the community can increase participation and improve quality of life.[7,11]

4. A common approach to managing lower extremity motor control impairments resulting from a stroke is to use an orthotic device, most commonly an AFO. Meta-analyses have shown a positive impact of AFO on gait speed, cadence, step and stride length, ankle and knee kinematics, balance, endurance, and functional ambulation category.[12,13]

   Nikamp et al investigated the impact of early versus late provision of an AFO and found significant effects on balance, walking ability, functional mobility, and independence in both groups. Positive effects were more pronounced when the AFO was provided early after stroke.[14] A study investigating the effects of articulated versus fixed AFO combined with a program involving home-based mobility tasks, found better performance on measures of balance and functional mobility postintervention in the articulated AFO group.[15] Wu et al investigated the effects of an AFO in patients poststroke stratified according to Brunnstrom stages (III, IV, V). AFO significantly improved gait parameters, with the greatest benefit observed for those with severe impairments (stage III).[16]

   FES is another approach to address foot-drop poststroke. A meta-analysis found a significant effect of both FES and AFO on walking speed and balance as compared with controls, with no significant differences between FES and AFO.[19]

Bethoux et al compared the use of the WalkAide FES system with AFO. Both approaches significantly improved gait parameters, balance, functional mobility, and quality of life after 6 months.[18] Improvements in gait speed were maintained at the 12-month follow-up.[17]

5. Hand orthoses are often used as a part of a comprehensive stroke rehabilitation program for survivors with limited movement of the hand or excessive spasticity. Pritchard et al conducted a systematic review to determine the impact of static splinting on functional use of the affected extremity, contracture, and pain. Effect sizes were calculated for studies with stated significant results and were reported for outcomes found to be significant as follows: large effect size for wrist patient-reported outcome measure (single study); medium effect size with greater significance in wrist extension than flexion, and medium effect sizes for spasticity (single study); and large effect sizes in box and blocks test and Canadian Occupational Performance Measure (single study).[21]

   Similarly, Kerr et al found low strength of evidence (1 study with positive findings and 1 with negative findings) regarding the benefit of static splinting on reducing spasticity and moderate strength of evidence with respect to hand function (2 studies with positive findings and 1 with negative findings).[20]

   Overall, the results of both reviews were inconclusive secondary to lack of homogeneity of outcome measures, lack of universal classification of stroke stages, variability of study protocols, variance in study quality, and relatively small sample sizes.[20,21]

Knowledge Gaps and Future Research

- While adaptive and AD can benefit persons with stroke, it appears that system-level factors (ie, CARF accreditation, type of facility, and rehabilitation staffing), in addition to patient need, may significantly affect the provision of AD. Further research is needed to determine how best to address these system-level factors.[23]
- Nonrobotic dynamic hand orthoses are aids that can allow for performance of repetitive functional-based rehabilitation activities in persons with stroke who have moderate to severe impairments in upper limb capacity. These devices are not controlled by a computer program, sensory feedback, or information processing and can be used in community and home environments. A meta-analysis found positive effects in favor of nonrobotic dynamic hand orthoses for 2 outcomes: upper limb function (action research arm test) and dexterity (box and blocks test). Results are encouraging, but the studies included were small with high risk of bias, and study protocols varied considerably. Further research is needed.[22]
- Wearable robotics (exoskeletons) and soft-wearable robotics (exosuits) also have the potential to increase access to repetitive task practice and support performance of ADLs, including functional mobility, but both require further research.[25–27]
- Assistive technology, such as personal digital assistants, household robotics, smart watches and clothes, and sensor-based home monitoring systems, may improve activity and participation after stroke.[28–30] Additionally, a small study found that technology-assisted toilets improved the psychosocial outcomes of persons with stroke when compared with standard toileting, and completely cleaned participants in most cases.[31] Larger trials are needed to confirm assistive technology's benefit in stroke rehabilitation.

5.8. Lifestyle Modification and Management

Recommendations for Lifestyle Modification and Management
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
Exercise		
1	A	1. In persons with stroke who are physically able, engaging in at least moderate-intensity aerobic activity for a minimum of 10 minutes 4 times per week or vigorous-intensity aerobic activity for a minimum of 20 minutes twice per week is indicated to lower the risk of recurrent stroke and the composite cardiovascular end point of recurrent stroke, myocardial infarction, or vascular death.[1]
2a	A	2. In persons with stroke who are physically able, engaging in exercise classes* that include counseling to improve physical activity behavior can be beneficial for reducing cardiometabolic risk factors and increasing leisure-time physical activity (LTPA) participation.[2,3]
2a	B-R	3. In persons with deficits after stroke that impair their ability to exercise, supervision of an exercise program* by a health care professional, in addition to routine rehabilitation, can be beneficial for secondary stroke prevention.[2]
2b	B-NR	4. In persons with stroke, breaking up long uninterrupted sedentary periods with short periods of standing or light exercise every 30 minutes may be reasonable to improve cardiovascular health.[4]
Nutrition		
2a	B-R	5. In persons with stroke, a Mediterranean diet† is reasonable to reduce the risk of recurrent stroke.[5,6]
1	B-R	6. In persons with stroke, reducing dietary sodium by ≥1 g/d as part of healthy eating is recommended to decrease the risk of stroke, major cardiovascular events, and mortality.[7,8]

Recommendations for Lifestyle Modification and Management (Continued)

COR	LOE	Recommendations
Smoking Cessation		
1	A	7. In persons with stroke who smoke tobacco, counseling with or without drug therapy‡ is recommended to assist in quitting smoking.[9,10]
1	B-NR	8. Persons with stroke should avoid secondhand smoke to reduce poststroke mortality and recurrent stroke risk.[11,12]
Substance Use and Alcohol		
1	B-NR	9. In persons with stroke who have >2 drinks of alcohol per day for men and >1 drink of alcohol per day for women, counseling, education, and behavioral strategies to abstain from or reduce alcohol consumption should be offered to decrease stroke and major cardiovascular event risk.[13]
1	C-EO	10. In persons with stroke who abuse stimulants§ or have infective endocarditis in the context of intravenous drug use, health care providers should counsel them to stop and/or refer them to appropriate addiction programs to reduce the risk of recurrent stroke.[14,15]
1	B-NR	11. In persons with stroke who have a substance use disorder (drugs or alcohol), specialized addiction treatment‖ is recommended to manage dependency and reduce risk of recurrent stroke and mortality.[16,17]

*Any combination of aerobic exercise (continuous activity that engages large muscle groups) and resistance exercise (activity that induces muscle contractions against an external load).

†Emphasizing vegetables, fruits, whole grains, legumes; limit saturated fats, trans fats, refined carbs; choose lean proteins and fish.

‡Nicotine replacement, bupropion, or varenicline.

§For example, amphetamines, amphetamine derivatives, cocaine, or khat.

‖Including behavioral therapy and pharmacotherapy.

The recommendations above have been adapted or modified from the AHA/ASA 2024 Primary Prevention of Stroke Guideline.[18]

Synopsis

Secondary prevention targeting modifiable risk factors such as physical inactivity, nutrition, and substance use throughout stroke rehabilitation is crucial, as it reduces the 25% to 30% risk of recurrent stroke within 5 years and improves patient outcomes and independence.[19,20] Systematic reviews and guidelines emphasize that behavioral interventions (eg, nurse-led or shared care models) significantly improve lifestyle behaviors and physiological outcomes like blood pressure and cholesterol.[21] Multimodal strategies that combine behavioral changes with pharmacological management further reduce recurrence and enhance independence.[22] Educational interventions can improve health literacy and some health behaviors, though their impact on smoking, alcohol use, and weight is limited.[20] Integration of these strategies from acute hospitalization through community rehabilitation is recommended consistently, although challenges remain in sustaining behavior change and translating knowledge into practice. Overall, comprehensive risk factor management is essential for reducing poststroke morbidity and mortality.[19–22] For further information on the prevention of stroke, please refer to the 2024 Guideline for the Primary Prevention of Stroke: A Guideline From the American Heart Association/American Stroke Association[18] and the 2021 Guideline for the Prevention of Stroke in Patients with Stroke and Transient Ischemic Attack: A Guideline From the American Heart Association/American Stroke Association.[19]

Recommendation-Specific Supportive Text

1. Regular physical activity remains a cornerstone of secondary stroke prevention. The Stenting and Aggressive Medical Management for Preventing Recurrent stroke in Intracranial Stenosis (SAMMPRIS) trial demonstrated that greater levels of physical activity were strongly associated with reduced risk of recurrent vascular events in patients receiving intensive risk factor management, with inactivity emerging as 1 of the strongest predictors of poor outcomes.[1]
2. Structured programs that combine exercise with counseling to promote sustained physical activity demonstrate improvements in cardiometabolic risk profiles. A systematic review and meta-analysis of 22 RCTs found that lifestyle interventions, including exercise programs, significantly lowered systolic blood pressure (mean reduction, −3.6 mm Hg) compared with usual care.[3] Similarly, another meta-analysis reported that exercise interventions reduced systolic blood pressure by ≈5 mm Hg, lowered fasting glucose and insulin, and increased high-density lipoprotein cholesterol, highlighting robust cardiometabolic benefits.[2] Although reductions in hard outcomes (stroke, myocardial infarction, vascular death) remain unproven, the consistency of risk factor improvement justifies upgrading the LOE to “A.”
3. For patients with poststroke deficits that impair independent exercise participation, supervised exercise programs led by physical therapists or cardiac rehabilitation professionals provide additional benefits. Meta-analyses confirm that supervised interventions as a complement to standard rehabilitation are effective in improving vascular risk factors, including blood pressure, glucose, and lipid profiles.[2]
4. Persons with stroke are at particularly high risk for sedentary behavior. The Breaking Up Sitting Time after Stroke (BUST-Stroke) trial demonstrated that interrupting prolonged sitting with short bouts of light-intensity activity (3 minutes of standing or walking every 30 minutes) reduced systolic blood pressure by approximately 3 to 5 mm Hg.[4] Although these are short-term physiological improvements without long-term event data, the results reinforce

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the potential cardiovascular benefit of reducing sedentary time.

5. Mediterranean and plant-forward diets reduce cardiovascular risk, including stroke. In the reanalyzed Prevention with Mediterranean Diet (PREDIMED) trial, participants assigned to a Mediterranean diet with extra virgin olive oil or nuts had significantly fewer major cardiovascular events compared with a low-fat diet (HR, 0.69 and 0.72, respectively).[6] The CORonary DIet Intervention with Olive oil and cardiovascular PREVention (CORDIOPREV) trial further demonstrated superiority of the Mediterranean diet over a low-fat diet for secondary prevention in patients with coronary heart disease, showing HRs of 0.72 to 0.75 for major adverse cardiovascular events across 7 years.[5]
6. Sodium reduction lowers blood pressure and cardiovascular risk. The Salt Substitute and Stroke Study (SSaSS) randomized 20 995 participants (most with stroke or hypertension) to a reduced-sodium, potassium-enriched salt substitute. Compared with regular salt, substitution reduced stroke (RR, 0.86), major cardiovascular events (RR, 0.87), and mortality (RR, 0.88), without excess hyperkalemia.[7] A meta-analysis of 21 trials (n≈31 949) confirmed consistent reductions in systolic (−4.6 mm Hg) and diastolic (−1.6 mm Hg) blood pressure across populations, with parallel reductions in cardiovascular events (RR, 0.89) and mortality.[8]
7. Smoking cessation is critical for secondary stroke prevention. The Evaluating Adverse Events in a Global Smoking Cessation Study (EAGLES) trial (n=8144) demonstrated that varenicline, bupropion, and nicotine replacement therapy (NRT) were all effective, with varenicline yielding the highest abstinence rates (OR, 3.61 versus placebo).[9] Importantly, concerns regarding neuropsychiatric adverse events were not substantiated, even among participants with psychiatric disorders. Similarly, cardiovascular safety analyses showed no excess risk of major adverse events with varenicline, bupropion, or NRT compared with placebo.[10] Current evidence supports combining behavioral support with pharmacotherapy, with varenicline or combination NRT as preferred first-line agents, while bupropion and single-form NRT remain effective alternatives.
8. Secondhand smoke (SHS) exposure significantly worsens outcomes after stroke. In the National Health and Nutrition Examination Survey data (n=27 836 never-smokers), persons with stroke exposed to SHS had 50% greater odds of exposure than nonstroke individuals, and SHS was associated with a 2-fold increase in poststroke mortality.[23] These findings reinforce the importance of counseling patients with stroke or transient ischemic attack to avoid SHS (and thirdhand smoke) to reduce both recurrent events and mortality.
9. Heavy alcohol use increases cardiovascular and stroke risk. The 2025 AHA Scientific Statement concluded that ≥3 drinks per day or binge drinking is consistently linked to higher rates of stroke, atrial fibrillation, heart failure, and mortality, with no cardiovascular benefit at any level.[13] Counseling, education, and behavioral strategies remain essential to reduce consumption in patients with stroke or transient ischemic attack exceeding >2 drinks/day (men) or >1 drink/day (women).
10. Stimulants, including cocaine and amphetamine-type substances, substantially increase stroke risk. A 2023 systematic review and meta-analysis of 36 studies (721 702 individuals) found that cocaine use was associated with a 5-fold increase in ischemic, intracerebral, or subarachnoid hemorrhage, and higher mortality (OR, 1.77).[15] A systematic review of ATS used reported elevated ischemic and hemorrhagic stroke risks, with adjusted rate ratios ranging from 1.6 to 3.4 in cohort studies.[14] Counseling should emphasize complete cessation, with referral to addiction programs when appropriate, as continued use markedly increases recurrent stroke risk.
11. Specialized services are indicated for individuals with substance use disorders (alcohol, opioids, stimulants, cannabis). National inpatient data (1993–2015) showed an 8-fold rise in stroke hospitalizations associated with infective endocarditis and opioid use, particularly among younger adults and non-Hispanic white patients.[16] The 2022 AHA Scientific Statement emphasized the need for integrated, multidisciplinary care combining infectious disease, cardiology, and addiction medicine to improve outcomes in people with injection drug use–related endocarditis.[17]

Knowledge Gaps and Future Research

- For exercise, the optimal dose-response and sequencing of aerobic, resistance, and task-specific training remain undefined, and the effectiveness of remote or telesupervised programs for sustaining adherence and preventing recurrence is unknown.
- For nutrition, further research is needed on the comparative effectiveness of sodium-reduction strategies (education versus salt substitutes versus policy measures) and on the safety of potassium-enriched substitutes in patients with chronic kidney disease, frailty, or polypharmacy.

- For smoking, stroke-specific cessation trials are lacking, particularly regarding timing of intervention, inpatient-to-outpatient transition, digital tools, and tailoring strategies for survivors with aphasia, cognitive deficits, or co-occuring substance use; the impact of cessation on recovery trajectories is also uncertain.
- For substance use, randomized trials of alcohol reduction and pharmacotherapies for alcohol use disorder are absent, and the differential effects of alcohol, stimulants, and opioids by stroke subtype and interaction with atrial fibrillation and anticoagulation require study.
- Across all domains, inclusion of underrepresented populations and integration of addiction and behavioral medicine into stroke systems of care are critical unmet needs.

5.9. Treatment and Interventions for Visual Impairments

Recommendations for Treatment and Interventions for Visual Impairments
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
Deficits in Eye Movements		
1	A	1. In persons with convergence insufficiency poststroke, eye exercises are recommended to improve ocular convergence.[1,2]
2a	B-R	2. In persons with eye movement deficits poststroke, compensatory training can be useful for improving performance of ADLs.[3,4]
2a	C-LD	3. In persons with eye movement deficits poststroke, compensatory training can be useful for improving scanning and reading outcomes.[5,6]
Deficits in Visual Fields		
2a	B-R	4. In persons with stroke with deficits in visual fields, prisms can be useful to help compensate for visual field cuts.[7–9]
2a	B-R	5. In persons with stroke with deficits in visual fields, compensatory scanning training can be useful for improving vision-related quality of life after visual field loss, but it is not effective at improving visual field deficits.[8–13]
2b	B-R	6. In persons with stroke with deficits in visual fields, computerized vision restoration training may be considered to expand visual fields and to improve vision-related quality of life.[14–18]
Visual-Spatial/Perceptual Deficits		
1	B-R	7. In persons with stroke with visual-spatial/perceptual deficits, audio-visual spatial exploration training, in comparison with visual spatial exploration training alone, is recommended to improve visual scanning.[19–21]
2b	B-NR	8. In persons with stroke with visual-spatial/perceptual deficits, the use of VR therapy may be considered to improve visual-spatial and perceptual functioning.[22,23]

Recommendations for Treatment and Interventions for Visual Impairments (Continued)

COR	LOE	Recommendations
3: No Benefit	B-NR	9. In persons with stroke with visual-spatial/perceptual deficits, eye exercises and the use of lenses and colored filters are not recommended to improve eye movement control, eye focusing, and eye coordination.[24]

Synopsis

Individuals can experience a variety of visual impairments poststroke including eye movement deficits (eg, convergence insufficiency, gaze palsy), visual field deficits (eg, hemianopsia, quadrantanopia), and visual perceptual impairments.[25] Interventions are designed to target specific visual impairments, thus, the evidence supporting interventions is specific to the impairment being addressed. Three primary intervention approaches are used to address visual impairments: restitutive, compensatory, and substitutive.[8,26] Restitutive interventions (eg, eye exercises) aim to restore visual function, while compensatory interventions (eg, scanning training) focus on teaching individuals new techniques and strategies to improve daily functioning.[8,26] Substitutive interventions utilize equipment, optical devices (eg, prisms), or environmental modifications to improve functioning.[8] There have been several systematic and scoping reviews of treatments for visual impairments that have been published since 2014.[5,8,19,27–30] Importantly, the vast majority of research regarding interventions for individuals with eye movement deficits has been conducted with either mixed populations (eg, traumatic brain injury and stroke) or the general population.[1,2,5] Evidence related to interventions for visual field deficits focuses primarily on the use of prisms and compensatory scanning training,[8] while there is more mixed evidence regarding the effectiveness of computerized vision restoration training.[8,14,18,31] Few evidence-based interventions exist that address visual perceptual function.[26]

Recommendation-Specific Supportive Text

1. The prior 2016 guideline highlighted evidence supporting the use of eye exercises for the treatment of convergence insufficiency. We did not identify any new evidence that supports or refutes the 2016 guideline recommendation at this level of evidence. However, a 2022 Cochrane review[10] and 2018 review paper[11] indicate that the available evidence for treatment of convergence insufficiency is largely for the general population (adult and pediatric) and is not specific to individuals with neurological conditions including stroke.[1,2]
2. A double-blinded RCT of 64 participants with eye movement disorders found that compensatory visual scanning exercises combined with task-specific training were more effective at improving

functional balance (measured by the Berg Balance Scale) and independence in ADLs (measured by the Barthel Index) than placebo eye exercises combined with task-specific training.[3] Additionally, findings from a pilot single-group pre-post intervention study of 30 participants with binocular vision disorders and concurrent balance impairments suggest that participation in an intensive group training program and daily home exercise program (focused on visual therapy and balance training) may improve balance, walking speed, health-related quality of life, visual function, and functional outcomes.[4] Together, these studies support the use of compensatory visual training for improving performance of ADLs.

3. We did not identify any new studies with individuals with eye movement deficits poststroke that were published since 2014 that support or refute the previous 2016 guideline recommendation. A 2018 Cochrane review[5] of interventions for eye movement disorders due to acquired brain injury highlighted the lack of available evidence for persons with stroke. This review included only a single crossover design study[6] that was conducted with individuals with mild traumatic brain injury and examined the effects of compensatory training on scanning. While these findings generally support the recommendation, it is not specific to persons with stroke.
4. A 2019 Cochrane review[2] identified 1 study[32] (n=39) that demonstrated a significant treatment effect of prisms on scanning during reading activities. There is also some evidence that individuals perceive a benefit to wearing prism glasses. A double-blinded randomized crossover design study of 61 participants (47 with stroke) found that a significantly greater proportion of individuals wanted to continue to wear real prisms (57-diopter prisms, ≈30 degrees) than sham prisms (<5-diopter prisms) after treatment.[7] While both groups reported significant improvements in mobility, there were no statistically significant differences between groups.[12] A pilot single-blinded RCT of 87 participants with homonymous hemianopia poststroke compared the effects of 3 interventions (wearing 40-diopter prisms, visual scanning training, and education) on functional activities and found that there was no significant difference in improvements for 5 of 6 self-reported functional activity measures.[9] Findings suggest that all 3 interventions may be useful at improving functional outcomes. It is important to note however, that there were minor adverse events (eg, headaches, diplopia) for the prism group.[9]
5. A Cochrane review found that there was a significant effect of scanning training on vision-related quality of life (measured by Visual Function Questionnaire) when compared with a control/placebo intervention.[8] Additionally, a randomized controlled parallel-group design study found that participants with visual field deficits (stroke, traumatic brain injury, brain tumor) who completed an unsupervised home-based compensatory training program focused on reading and exploration computer training demonstrated significant improvements in quality of life on most items on the Visual Function Questionnaire, while those who received the control intervention demonstrated significant improvement on 1 item.[10] Findings from a large interventional cohort study indicate that the use of a web-based scanning app may improve self-reported performance of ADLs for those with hemianopia or concurrent hemianopia and neglect.[13] Additionally, an RCT (n=87) comparing Fresnel prism therapy, visual scanning training, and standard of care found that the visual scanning group had significantly greater improvements in quality of life compared with other groups.[9] There were no significant changes in visual fields across groups.[23] Lastly, a Cochrane review found that there was no statistically significant effect of scanning training on visual fields compared with a control or placebo.[8] Despite these findings, 1 RCT (n=161) found that there was no significant difference in change in quality of life for individuals who received visual scanning training (fast saccadic scanning) versus sham training (scanning with slow pursuit).[12] Importantly, the sham intervention may have provided an active intervention. Therefore, additional research is warranted to further investigate these interventions.[12]
6. A multicenter single-blinded RCT examined the use of a 12-week personalized visual perceptual learning program delivered via a VR head-mounted display and found that participants in the intervention group had a significantly greater improvement in the whole visual field and defective visual hemifield when compared with the control group (no treatment).[18] Adverse events for the intervention group were relatively mild (eg, dizziness, headache).[18] Findings from 2 randomized controlled crossover design studies indicate that computerized visual discrimination training delivered at home can improve visual fields (measured with perimetry).[15,16] One of these studies also found that there was a significant improvement in quality of life for some of the outcome measures post-training.[15] In addition, a nonrandomized crossover design study found that individuals with visual field deficits poststroke (n=18) experienced a significantly greater improvement in the whole visual field

and the defective visual field after participating in an 8-week computerized visual discrimination training program compared with no training.[18] This study also found that there was a significant improvement on the social functioning subscale of the Visual Function Questionnaire post-treatment.[18] Despite these findings, there is some mixed evidence regarding the effectiveness of computerized vision restoration training.[8,14–18]

7. A systematic review found 7 original research studies that compared audio-visual training with visual training.[7] Meta-analyses could not be conducted due to the heterogeneity of the studies.[19] While there were differences in the dose and training protocols delivered, findings supported the use of audio-visual training to improve visual scanning over visual-spatial exploration alone.[19] This review included 2 RCTs that supported the prior recommendation and level of evidence. Additionally, findings from a single-arm assessor-blinded study found that individuals who participated in an intensive telerehabilitation-delivered audio-visual training program saw a significant improvement in visual search accuracy, reading speed, and vision-related activities of daily living.[20] However, there was no evidence that participation in the training impacted visual field perimetry.[20] Similarly, a single-group pre-post design study found that individuals (n=10) who participated in an intensive intervention program that provided unisensory visual stimulation, unisensory auditory stimulation, and multisensory audio-visual stimulation had significant improvements in visual search, self-reported ADLs, and oculomotor parameters (eg, faster saccades, decreased visual exploration time), and that these improvements were sustained long term.[21] These changes were also accompanied by changes in electroencephalography measures providing preliminary evidence of plasticity.[21]
8. A pre-post design study examined the effects of a 14-day VR training program on neuropsychological outcomes and found that the persons with stroke with visual field cuts (n=20) experienced significant improvements in visual-spatial memory that were not observed in healthy controls (n=20). Participants in both groups demonstrated significant improvements for several neuropsychological domains (eg, visual scanning, attention, visuo-construction, mental rotation).[22] In addition, a pilot RCT found that individuals who received VR balance training delivered via the Wii Fit had a significantly greater improvement in visual perception (measured by the Motor-Free Visual Perception Test-3), balance (measured by Berg Balance Test), and mobility (Timed Up & Go Test) compared with those who received balance training without the use of VR.[23] While these findings show promise, this study did not include blinding or any long-term follow-up, and the generalizability of the intervention should be considered, as individuals were required to be able to stand for 30 minutes independently to qualify for study participation.[23] Therefore, the level of evidence from the prior 2016 recommendation was maintained at B-NR.
9. Barrett[24] reviewed the behavioral optometry literature. Behavioral optometry proposes that eye and visual function can be improved through various vision therapy methods, including eye exercises and the use of lenses, prisms, filters, occluders, specialized instruments, and computer programs to improve vision skills such as eye movement control, eye focusing, and coordination. Barrett concluded that there is a paucity of controlled trials in the literature to support behavioral optometry approaches and that a large majority of behavioral management approaches are not evidence-based.

Knowledge Gaps and Future Research

- There is a clear need for additional studies that examine interventions specifically for individuals with eye movement deficits poststroke.
- Additionally, large, high-quality RCTs are needed to expand the evidence related to the use of prisms and visual scanning for individuals with visual field deficits given the heterogeneity of studies (eg, dose, outcome measures) and lack of evidence regarding long-term outcomes. In addition, high-quality studies are needed to help clarify whether computerized vision restoration training can reduce visual field loss.
- Although not FDA approved, preliminary evidence suggests that various forms of noninvasive brain stimulation such as repetitive transorbital alternating current stimulation (rTACS) or tDCS are feasible and safe for individuals with visual field cuts poststroke.[27,33,34] While these interventions show promise for improving visual fields, evidence is mixed, underscoring the need for larger RCTs.
- While there is evidence to support the use of multimodal audio-visual spatial exploration training, the underlying neural mechanisms are not well understood.[19] Studies that incorporate imaging and physiological data (eg, electroencephalography) can provide useful information to help refine future intervention training protocols.[19]
- Shockingly, there continues to be a dearth of evidence available regarding interventions to reduce the impact of impaired visual perceptual functioning.[26,29] Well-designed studies are needed to systematically develop and test interventions and

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examine both the short- and long-term effects of these interventions on daily life.[26,29]

5.10. Dysphagia Screening, Management, and Nutritional Support

Recommendations for Dysphagia Screening, Management, and Nutritional Support
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-R	1. For persons with acute stroke, dysphagia screening should be performed as soon as possible (within 24 hours of admission) and before the person begins eating, drinking, or receiving oral medications to identify individuals for a full evaluation.[1–3]
1	B-NR	2. For persons with stroke, dysphagia screening should be performed using a formal, validated tool that, at minimum, includes observing attempts to swallow liquids of different volumes to identify those at risk for dysphagia.[3–9]
1	B-NR	3. For persons with stroke and suspected dysphagia, instrumented swallow studies should be chosen over noninstrumented or “bedside” swallow studies to verify the presence/absence of aspiration, to determine the biomechanical reasons for dysphagia, to identify the least restrictive oral diet, and to guide the treatment plan with greater precision.[2,9–18]
2a	C-LD	4. For persons with stroke, it is reasonable to perform dysphagia screening within 24 hours of admission to a new care setting to identify patients who remain at risk for dysphagia.[19]
2a	B-R	5. For persons with stroke, dysphagia screening is reasonable by a speech-language pathologist, nurse, or other trained health care provider to identify those at risk for dysphagia.[2,3,20,21]
2a	B-NR	6. In persons with stroke receiving instrumented swallow studies, it is reasonable to assess pill swallowing to determine safe and efficient methods of oral medication administration.[22,23]
2a	B-NR	7. For persons with stroke and suspected dysphagia, assessment of oral, pharyngeal, and laryngeal sensory function and oral and pharyngeal swallowing pressures is reasonable as an adjunct to instrumented swallow studies to determine the biomechanical reasons for dysphagia and to guide the treatment plan.[9,24–32]
2a	C-LD	8. For persons with acute stroke, instrumental swallow studies within the first 4 days of admission or within 24 hours of extubation are reasonable to identify the least restrictive diet.[13,16,33–35]
2a	B-NR	9. In persons with dysphagia after stroke, repeated comprehensive swallowing assessment is reasonable within 3 months of discharge from the acute setting to facilitate dysphagia recovery and to identify the least restrictive oral diet.[36–38]

Recommendations for Dysphagia Screening, Management, and Nutritional Support (Continued)

COR	LOE	Recommendations
Management		
1	B-NR	10. For patients with stroke-associated dysphagia, behavioral swallowing treatment is effective for improving swallowing function, increasing tolerance of food textures, reducing the risk of negative health outcomes, and improving quality of life.[39–60]
2a	B-R	11. For patients with stroke-associated dysphagia, biofeedback can be a useful addition to behavioral swallowing treatment for improving swallowing function, increasing tolerance of food textures, and improving quality of life.[61–67]
2b	B-R	12. For patients with stroke-associated dysphagia, pharyngeal electrical stimulation (PES) may be considered to improve swallowing function, increase tolerance of food textures, reduce the risk of negative health outcomes, and improve quality of life.[68–72]
2b	B-R	13. For patients with stroke-associated dysphagia, the effectiveness of neuromuscular electrical stimulation in addition to behavioral swallowing treatment is unknown for improving swallowing function, increasing tolerance of food textures, and improving quality of life.[53,73–84]
2b	B-NR	14. For patients with stroke-associated sialorrhea, medical management with atropine or botulinum toxin injection may be effective at reducing symptoms of drooling.[85,86]
Nutritional Support		
1	B-R	15. For patients with stroke-associated dysphagia in the acute phase, early nutrition support is recommended to improve nutritional status, improve functional outcomes, and reduce adverse events.[87–92]
1	B-NR	16. For patients with stroke-associated dysphagia in the subacute and chronic phases, nutritional support is effective for improving functional outcomes.[93–95]
1	B-NR	17. For patients with stroke-associated dysphagia, percutaneous gastrostomy tubes are recommended in preference to nasogastric (NG) tubes for improving nutritional status and reducing adverse events in patients with dysphagia with a chronic inability to swallow safely.[96–99]
2a	B-R	18. For patients with stroke-associated dysphagia, it is reasonable to consider nasojejunal tubes or intermittent oroesophageal tube feeding over NG tubes for short-term nutritional support for patients who cannot swallow safely.[100–103]

Synopsis

Dysphagia is a common and high-risk complication of stroke, contributing to aspiration pneumonia, malnutrition, dehydration, and poorer functional outcomes. Early identification via validated screening tools is essential, as demonstrated by systematic evidence showing reduced pneumonia and mortality when structured screening is performed shortly after admission.[2,3] Screening should be conducted by trained professionals using tools that include direct observation of swallow attempts, which improves accuracy over informal bedside judgment. Failure of swallowing screens should result in comprehensive swallowing evaluation by trained specialists, such as speech-language pathologists or occupational therapists with dysphagia training.

Instrumented swallowing assessments, including videofluoroscopy and fiberoptic endoscopic evaluation of swallowing (FEES), provide details of the swallowing physiology and biomechanics that clinical examination cannot capture. Early performance utilization of FEES or videofluoroscopic swallowing studies (VFSS), within 4 days of admission or within 24 hours after extubation, supports safer diet initiation and shortens hospitalization.[13,16,33] Repeated assessments within the first 3 months of recovery help guide the transition from enteral feeding, refine diet prescriptions, and capture substantial improvements in swallow function.[37]

Behavioral swallowing therapy remains the cornerstone of dysphagia rehabilitation, with strengthening exercises and targeted maneuvers improving swallow safety and efficiency.[40,45] Adjunctive modalities, such as biofeedback or PES, may further enhance recovery in selected patients, though their mechanisms and optimal protocols require further study.[64,71]

Nutritional support, both early in the acute phase and sustained through rehabilitation, plays a key role in recovery, improving functional outcomes and supporting safe oral intake trajectories.[89,93] Collectively, these interventions form an integrated, evidence-based approach to optimizing swallowing safety, nutritional adequacy, and long-term recovery after stroke.

Recommendation-Specific Supportive Text

1. Dysphagia screening is a critical early intervention in acute stroke care, given the high prevalence of swallowing impairment and its association with aspiration pneumonia, malnutrition, prolonged hospitalization, and mortality. Evidence consistently demonstrates that timely, standardized dysphagia screening supports better clinical outcomes. In a large systematic review of stroke care quality, Urimubenshi et al found that adherence to dysphagia screening as a key performance indicator was significantly associated with reduced pneumonia rates and overall improved patient outcomes, underscoring its value as a core element of organized stroke systems.[1]

   More recent high-quality evidence reinforces these conclusions. A Cochrane review by Boaden et al evaluated tools used to screen for aspiration risk and highlighted that structured screening protocols, when performed by trained personnel, improve the detection of clinically important swallowing impairments and enable earlier initiation of appropriate management strategies.[2] Complementing this, a meta-analysis by Sherman et al demonstrated that implementing dysphagia screening in adults with stroke significantly reduces the odds of pneumonia and is associated with decreased mortality, supporting its role in improving patient safety and overall outcomes.[3]
2. Use of validated dysphagia screening tools is essential for reliably identifying swallowing impairment and aspiration risk after stroke, particularly because informal or unstructured assessments often miss clinically important deficits. A meta-analysis by Sherman et al demonstrated that dysphagia screening significantly reduces pneumonia and mortality in adults with stroke, with the greatest benefits observed when screening was performed using structured, validated approaches.[3] In contrast, additional work by Sherman and colleagues showed that informal detection, based solely on clinician judgment or nonspecific signs, has poor sensitivity, reinforcing the need for standardized tools and direct observation of swallowing attempts.[5] Studies evaluating adjunctive screening methods further highlight the limitations of relying on indirect indicators.

   Cough testing may help identify silent aspiration; the citric acid cough test demonstrated utility in detecting high-risk patients, though it is not sufficient as a standalone method.[4] More recent work suggests that combining clinical examination with cough reflex testing is feasible but still requires validation before routine acute-stroke use.[7] Conversely, pulse oximetry and oxygen desaturation measures have been shown to lack diagnostic accuracy for aspiration in stroke populations.[6,8] Finally, emerging screening metrics such as tongue-pressure testing and repetitive saliva-swallowing assessments show promise but require further evaluation against gold-standard videofluoroscopy.[9]
3. Instrumented swallow evaluations, including VFSS and FEES, provide critical physiologic information that cannot be reliably obtained through noninstrumented clinical assessments alone. Noninstrumented tools and bedside screening methods are valuable for initial triage, but their accuracy is variable, and they cannot directly visualize aspiration, residue, or specific physiologic impairments. The 2021 Cochrane review on aspiration risk screening emphasized that clinical tests frequently lack sensitivity compared with instrumented evaluations, underscoring the need for confirmatory studies when impairment is suspected.[2] Similarly, recent prospective work demonstrated that screening methods such as tongue-pressure testing or repetitive saliva swallowing have limited agreement with detailed VFSS findings.[9]

   A substantial and growing evidence base supports FEES and VFSS for guiding precise, individualized management in patients with stroke. FEES-specific studies show consistent clinical impact: speech-language pathologist–led FEES improves functional outcomes,[10] has a strong safety profile,[11] and leads to more accurate diet adjustments in both acute and neuro–intensive care unit settings.[12,14] Early FEES assessments are also associated with reduced length of stay when paired with timely nutritional intervention[13] and help identify aspiration risk following high-acuity interventions such as mechanical thrombectomy.[16] Narrative reviews further reinforce that FEES and VFSS remain the gold standards for defining swallowing physiology and aspiration risk, outperforming noninstrumented approaches.[15]

4. Timely dysphagia screening is essential in acute stroke care, and evidence increasingly supports screening as early as possible, ideally within the first 24 hours of hospital admission. A recent systematic review by Mancin et al synthesized contemporary research on poststroke dysphagia screening and identified early screening as a consistent predictor of improved clinical outcomes. The review noted that delays in screening were associated with higher rates of aspiration pneumonia, longer hospital stays, and increased complications related to missed or untreated swallowing impairment. Conversely, early identification, particularly within the first day, allowed for prompt initiation of safe feeding strategies, nutrition planning, and referral for comprehensive assessment, thereby reducing preventable morbidity.[19]

   Mancin et al emphasized that early screening is feasible across diverse care settings when standardized protocols are in place and when nurses or trained clinicians perform the initial screen. The authors highlighted that screening within 24 hours not only aligns with best-practice stroke pathways but also contributes to more reliable stroke-care quality indicators. Importantly, the review found that early screening remains effective across different screening tools, supporting its broader implementation regardless of the specific protocol used.[19]

5. Dysphagia screening is most effective when performed by trained professionals using structured, validated methods. Evidence consistently shows that professional training, whether for speech-language pathologists, nurses, or other qualified clinicians, improves screening accuracy, reduces missed cases of aspiration risk, and supports safer, earlier clinical decision-making. The 2021 Cochrane review on dysphagia screening tools emphasized that proper training significantly enhances reliability and sensitivity, allowing screeners to better identify patients who require urgent assessment or dietary modification.[2] Similarly, a meta-analysis by Sherman et al found improved clinical outcomes, including reductions in pneumonia and mortality, when screening protocols were systematically implemented by trained personnel rather than through informal or unstructured bedside judgments.[3]

   Research specifically examining nurse-led screening demonstrates that appropriately trained nursing staff can achieve high levels of accuracy. Anderson et al reported that nurses using a structured aspiration screening protocol maintained good initial and sustained reliability, validating the feasibility of nurse-delivered screening in high-volume acute stroke settings.[20] More recent validation of the Swedish version of the Gugging Swallowing Screen further supports this model: trained clinicians achieved strong validity and interrater reliability, reinforcing that training is essential for consistent performance.[21]

6. Assessment of pill swallowing ability is an important but often overlooked component of dysphagia evaluation in patients with stroke. Many medications are administered in solid oral dosage forms, yet swallowing tablets or capsules poses a substantially higher risk of penetration and aspiration for individuals with impaired swallowing physiology. In a pivotal observational study, Schiele et al demonstrated that patients with stroke with dysphagia were significantly more likely to experience penetration or aspiration when swallowing solid medications compared with liquids or semisolids. The study highlighted that pill size, coating, and patient-specific deficits influence safety and that relying on a standard bedside swallow assessment without a pill-specific evaluation may miss clinically significant risks.[22]

   More recent evidence reinforces and expands upon these concerns. Trapl-Grundschober et al evaluated the safety of various solid medication forms in poststroke dysphagia and found that a substantial proportion of patients who could safely swallow small volumes of test liquids were nonetheless unsafe with tablets or capsules. The study emphasized that medication administration should be tailored based on a dedicated pill-swallowing assessment, ideally supported by instrumental evaluation when swallow safety is uncertain.[23] Both studies underscore that pill swallowing cannot be assumed safe even when other consistencies appear tolerated.

7. Comprehensive swallowing evaluations for patients with stroke benefit from incorporating assessments of oral, pharyngeal, and laryngeal sensory function alongside measures of swallowing pressures. Sensory deficits are common after stroke and strongly influence swallowing safety. Laryngeal sensory impairment has been directly associated with increased penetration and aspiration risk, highlighting the importance of assessing sensory responsiveness when evaluating dysphagia severity.[31] Similarly, oral tactile sensitivity and masticatory performance are often reduced following stroke,

affecting bolus control and oral transit.[32] Tongue pressure, a key marker of oral motor strength, correlates with both oral-phase impairment and functional outcomes, with multiple studies demonstrating relationships between reduced tongue pressure, oral dysphagia, and decreased daily functioning.[26,28] These findings were reinforced by recent work linking tongue pressure to detailed videofluoroscopic physiology in acute stroke.[9]

Assessments of pharyngeal swallowing pressures and upper esophageal sphincter function provide additional insights into aspiration risk and swallowing biomechanics. High-resolution pharyngeal manometry studies have shown strong correlations between manometric abnormalities and videofluoroscopic findings in brainstem and medullary strokes, including impaired upper esophageal sphincter relaxation, a known risk factor for aspiration.[24,26,30] High-resolution pharyngeal manometry research also demonstrates that pharyngeal pressure patterns differ by lesion location and can inform prognosis.[27]

8. Early instrumented swallowing assessment is increasingly recognized as essential for optimizing care and outcomes in patients with acute stroke or postextubation dysphagia. Evidence demonstrates that completing VFSS or FEES within the first several days of admission provides meaningful clinical and functional benefits. Ogawa et al found that early FEES followed by timely nutrition intervention was associated with shorter hospital stays in patients with acute cerebral infarction, highlighting the value of early physiologic assessment in guiding safe feeding pathways.[13] In patients undergoing mechanical thrombectomy, early FEES has been shown to identify aspiration risk promptly and support earlier initiation of appropriate diets, while maintaining a strong safety profile.[16,35]

   For patients with acute stroke and dysphagia, early VFSS similarly provides actionable information. Kim et al demonstrated that VFSS performed early during hospitalization identified clinically significant swallowing impairments and helped guide management decisions that improved functional recovery.[33] In the context of postextubation dysphagia, the timing of instrumental evaluation is equally important. Marvin et al reported that evaluation within 24 hours of extubation is associated with better detection of dysphagia and fewer delays in initiating safe oral intake.[34]

9. Repeated swallowing assessments in the early postdischarge period are essential for capturing recovery trajectories and ensuring appropriate adjustments to nutrition and diet plans in patients with poststroke dysphagia. Recovery of swallowing function is dynamic, particularly in the first several months after stroke, and early reassessment can identify meaningful improvements that support safe advancement of oral intake. In a study examining NG tube removal decisions, Hwang et al demonstrated that follow-up VFSS were instrumental in guiding timely transitions from tube feeding to oral intake, preventing prolonged reliance on enteral support.[36] Similarly, Pekacka-Egli et al found that reassessment during inpatient rehabilitation frequently revealed improvements in swallowing ability, leading to fewer diet restrictions and more individualized, less conservative dietary prescriptions.[37]

   Longitudinal evidence from the STROKE CARD trial further supports structured follow-up. In this intensified poststroke care model, Karisik et al reported that systematic reassessment, including evaluation of swallowing function, was associated with improved long-term dysphagia recovery and better functional outcomes. Their findings underscore the importance of scheduled, proactive evaluation rather than waiting for complications or patient-reported difficulties.[38]

10. Behavioral swallowing therapy is a core component of dysphagia rehabilitation after stroke, with strong evidence supporting its role in improving swallowing safety, functional recovery, and patient outcomes. A large 2025 cohort study demonstrated that structured dysphagia management, including clinician-guided behavioral exercises, was associated with significantly reduced mortality among patients with moderate-to-severe ischemic stroke, underscoring its importance in comprehensive stroke care.[39] Multiple RCTs and systematic reviews further confirm the efficacy of targeted oropharyngeal strengthening exercises. A recent meta-analysis showed that oropharyngeal muscle strength training improves swallowing physiology and reduces aspiration risk without significant adverse effects.[40]

    Specific rehabilitative techniques such as effortful swallow training, chin tuck against resistance, jaw-opening and hyolaryngeal exercises, and tongue-pressure resistance training have consistently demonstrated benefits across stroke populations. For example, effortful swallow protocols improve tongue strength and oropharyngeal kinematics,[45] chin tuck against resistance and other resistance-based exercises enhance suprahyoid muscle function,[42] and device-facilitated lingual strengthening improves swallow safety and efficiency.[52] Conventional therapist-led swallowing therapy has also been shown to improve functional outcomes in acute stroke.[44]

11. Biofeedback-enhanced swallowing therapy is an effective adjunct to conventional behavioral treatment for poststroke dysphagia. Surface EMG and kinematic visual biofeedback help patients learn and correctly execute targeted swallowing maneuvers by providing real-time information about muscle

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activation or movement patterns. Several RCTs demonstrate that biofeedback improves swallow physiology, safety, and functional outcomes. Game-based or intensive EMG biofeedback interventions have been shown to significantly improve swallowing function and reduce aspiration events compared with traditional exercises alone.[61,87] Similar benefits have been observed when surface EMG biofeedback is paired with rehabilitative game platforms, supporting both effectiveness and patient engagement.[63]

Biofeedback can also enhance motor learning of complex swallowing maneuvers. Visual kinematic biofeedback improves accuracy during training and increases the precision of clinician cueing, suggesting improved skill acquisition and generalization.[65] As an adjunct rather than a replacement for standard therapy, biofeedback has demonstrated added value: a pilot randomized trial found that integrating surface EMG biofeedback into conventional swallow therapy produced greater gains than conventional therapy alone.[64]

The mechanisms underlying these benefits may relate to improved timing and sequencing of pharyngeal events, areas known to be responsive to feedback-driven training.[67]

12. PES is an emerging neuromodulatory treatment for poststroke dysphagia that targets impaired pharyngeal motor and sensory pathways. Evidence from randomized trials and meta-analyses shows that PES can improve swallowing physiology, enhance airway protection, and support safer return to oral intake. A recent systematic review and meta-analysis of randomized controlled studies found that PES significantly improved swallowing safety and reduced aspiration, demonstrating consistent physiologic benefit across trials.[71] Trial-level data further support these findings: in the STEPS trial analysis, PES improved swallow timing, pharyngeal clearance, and airway protection in patients with poststroke dysphagia.[72]

    PES may be particularly useful for individuals recovering from mechanical ventilation. In a 2025 randomized pilot trial, Suntrup-Krueger et al reported that PES was safe, feasible, and associated with improved swallowing outcomes in postextubation patients with stroke. Additionally, PES delivered prior to extubation has been associated with reduced risk of extubation failure, suggesting potential preventive benefit in high-risk patients.[70]

13. Although NMES is widely used as an adjunct to behavioral swallowing therapy, evidence regarding its mechanisms, optimal application, and added benefit remains inconsistent. Systematic reviews highlight considerable variability across studies in electrode placement, stimulation parameters, treatment intensity, and patient selection—factors that limit the ability to draw firm conclusions about its efficacy. A 2022 meta-analysis found that outcomes differed substantially depending on electrode configuration and stimulation targets, suggesting that the physiologic effects of NMES are not yet fully understood.[76] Similarly, a 2024 meta-evaluation of RCTs concluded that while some patients experience improvements, others derive no greater benefit from NMES than from standard exercise-based therapy, underscoring heterogeneity in response.[73]

    Comparative clinical studies mirror these findings. Bengisu et al reported that NMES, conventional dysphagia therapy, and tDCS produced similar overall improvements in acute poststroke dysphagia, indicating that NMES does not consistently outperform behavioral interventions alone.[74] Trials evaluating sensory- versus motor-level stimulation also show mixed results, suggesting that the most effective stimulation mode remains unclear.[75]

    Overall, the evidence indicates that while NMES may be beneficial for some patients, its mechanisms, optimal protocols, and additive value beyond behavioral swallowing therapy remain uncertain, supporting cautious, individualized use.

14. Sialorrhea is a common and clinically significant complication in patients with stroke-related dysphagia, contributing to aspiration risk, reduced oral hygiene, and diminished quality of life. Pharmacologic management is often an important adjunct when behavioral or postural interventions alone are insufficient. Evidence supports both atropine and botulinum toxin type A as effective treatments for neurogenic sialorrhea.

    A 2024 RCT demonstrated that sublingual administration of atropine eye drops significantly reduced drooling severity in poststroke patients, with rapid onset of effect and favorable tolerability.[85] This noninvasive delivery route allows for ease of use and minimizes systemic anticholinergic effects, making it a practical option for medically complex patients.

    Botulinum toxin injections offer a targeted, longer-lasting alternative. Ultrasound-guided botulinum toxin type A injections into major salivary glands have shown high effectiveness in reducing salivary flow and improving swallowing-related outcomes among patients with neurogenic dysphagia, including those with stroke.[86] Residual gland specificity and ultrasound guidance enhance treatment precision and safety. Botulinum toxin type A is particularly useful when sialorrhea is persistent or severe, or when anticholinergic agents are contraindicated.

15. Early nutrition support is a critical component of acute stroke care, particularly for patients with dysphagia who are at increased risk for malnutrition, medical complications, and poorer recovery. Several studies demonstrate that earlier initiation of enteral

or structured nutritional therapy is associated with better clinical and functional outcomes. A retrospective cohort study found that higher levels of neuron-specific enolase, a marker of neuronal injury, were associated with more severe swallowing dysfunction, underscoring the heightened nutritional vulnerability of patients with dysphagia after acute ischemic stroke.[87] Early enteral nutrition has been shown to improve short-term prognosis, reducing complications such as infections and promoting metabolic stability.[88]

More recent prospective and propensity-matched analyses strengthen the case for timely nutritional intervention. Early nutritional support after endovascular thrombectomy was associated with improved recovery and better overall outcomes compared with historical controls.[89] Similarly, early initiation of nutrition was linked to more favorable discharge destinations, highlighting its role in fostering functional independence.[90] Additional studies demonstrate reductions in critical-care complications and improved biomarker profiles among patients receiving timely enteral nutrition.[91,92]

16. Adequate and sustained nutritional support during the subacute and chronic phases of stroke is essential for optimizing functional recovery, maintaining nutritional status, and supporting ongoing improvements in swallowing ability. Multiple studies demonstrate that nutritional status continues to influence recovery well beyond the acute phase. A prospective study by Nii et al showed that improvements in energy intake and nutritional markers were significantly associated with gains in functional independence among patients recovering from cerebrovascular disorders, emphasizing the long-term importance of meeting nutritional needs.[94]

More recent evidence reinforces the role of structured, individualized nutritional interventions. Shimazu et al found that frequent and personalized nutritional support during postacute rehabilitation improved nutritional status, ADLs, and dysphagia outcomes.[93] Their findings highlight that nutrition directly influences both systemic recovery and swallowing function, especially as patients transition back to community living or long-term care. Building on this, a 2025 multicenter randomized trial demonstrated that intensive nutritional support in subacute stroke led to greater functional recovery compared with standard care, supporting the integration of structured nutrition therapy into rehabilitative pathways.[95]

17. For patients with stroke-related dysphagia who require longer-term enteral nutrition, evidence increasingly supports PEG over prolonged NG tube feeding. PEG placement is recommended when dysphagia is expected to persist beyond the acute phase, as NG tubes are associated with greater discomfort, higher risk of tube dislodgement, and increased aspiration risk. A large population-based study showed that earlier transition to direct enteral tube placement, particularly PEG, was associated with improved outcomes and reduced in-hospital mortality following acute stroke, suggesting that timing of PEG placement is clinically meaningful.[97]

Comparative studies further highlight the advantages of PEG for persistent dysphagia. In older adults with long-term feeding needs, PEG use resulted in better nutritional maintenance and fewer complications than prolonged NG feeding, supporting its use when long-term enteral access is anticipated[98] More recent evidence in stroke-induced severe dysphagia found PEG superior to NG tubes for sustaining nutrition, reducing treatment failures, and minimizing adverse events.[99] Quality improvement work has also emphasized the need to ensure that PEG placement is used appropriately, reducing unnecessary procedures while still prioritizing timely transition from NG when indicated.[96]

18. Alternative enteral feeding strategies, such as nasojejunal tubes or intermittent oroesophageal tube feeding, may offer advantages over standard NG tubes for certain patients with stroke-related dysphagia.[100] A growing body of evidence indicates that these methods can improve nutritional delivery, reduce complications, and support patient comfort, especially when gastric retention, reflux, or aspiration risk limit the safety of traditional NG feeding. A systematic review and meta-analysis demonstrated that intermittent tube feeding was associated with better tolerance, fewer gastrointestinal complications, and improved feeding efficiency compared with continuous NG tube feeding.[100]

Patient-centered outcomes also favor alternative feeding modes. A propensity-matched longitudinal study found that feeding method significantly influenced patient anxiety levels, with intermittent or nongastric approaches associated with lower anxiety compared with continuous NG feeding,[101] highlighting the psychosocial impact of the tube-feeding modality. Randomized clinical trials further support physiologic benefits: intermittent oroesophageal tube feeding improved swallowing-related outcomes in patients with bulbar palsy after ischemic stroke, including reduced aspiration events and improved nutritional adequacy.[103] An additional randomized trial comparing feeding methods showed that non-NG approaches may enhance feeding satisfaction and reduce complications in broader stroke populations.[102]

Knowledge Gaps and Future Research

- Although many screening tools exist, there is limited evidence comparing their performance head-to-head in diverse clinical environments (eg, emergency departments, rehabilitation units).

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Research is needed to determine the most accurate, feasible, and scalable tools and to identify which components (eg, sensory testing, swallow observation) most strongly predict outcomes.
- There is no consensus among dysphagia experts as to which instrumented study is best for assessing swallowing function poststroke. VFSS and FEES are complementary studies, and neither is considered the gold standard.
- While evidence supports early assessment and repeated follow-up, optimal timing, particularly after extubation, thrombectomy, or clinical change, remains unclear. Prospective trials are needed to define the most effective assessment intervals and to personalize timing based on stroke characteristics or recovery trajectories.
- Across studies, the mechanisms of action, ideal stimulation parameters, and appropriate candidate profiles for neuromuscular or PES are poorly defined. Future research should clarify dose–response relationships, electrode placements, and which physiologic impairments respond best to each modality.
- Evidence suggests possible benefits of PEG over NG tubes and of nasojejunal or intermittent oroesophageal feeding in select patients, but high-quality comparative trials are limited. Research is needed to determine which patient subgroups benefit from each approach and to evaluate long-term outcomes such as aspiration pneumonia, quality of life, nutrition status, and caregiver burden.
- Although early and sustained nutrition support is clearly beneficial, it is not yet known how best to integrate nutritional strategies with behavioral swallowing therapy, instrumental assessment findings, or stroke rehabilitation milestones. Studies should explore interdisciplinary models that align nutrition, therapy intensity, and physiologic swallow recovery.
- Many studies focus on physiologic outcomes rather than patient-reported outcomes such as anxiety, treatment satisfaction, social participation, or caregiver burden. Future research should incorporate standardized patient-centered measures to ensure that therapies meaningfully improve quality of life.
- Evidence supports reassessment within the first 3 months, but the longer-term natural history of dysphagia recovery, particularly beyond 6 to 12 months, remains underexplored.[104] Predictive models integrating clinical, sensory, and manometric data may help guide long-term care planning and therapeutic intensity.
- Many clinical trials such as those by Wu et al and Cenci et al have assessed noninvasive neurostimulation approaches including rTMS and tDCS, many with encouraging findings.[105,106] However, these tools do not have an FDA-approved indication at this time.

6. COGNITION AND COMMUNICATION

6.1. Nonpharmacological Therapies for Cognitive Impairment, Including Memory

Recommendations for Nonpharmacological Interventions for Cognitive Impairment, Including Memory
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-R	1. In persons with stroke with cognitive impairments, supervised moderate- to high-intensity technology-supported cognitive training programs that are tailored and adaptive to performance are recommended to improve global cognition, attention, and working memory.[1–9]
2a	B-R	2. In persons with stroke with cognitive impairments, a combination of cognitive training and physical activity is reasonable to improve global cognition, working memory, and delayed recall.[10–16]
2a	C-LD	3. In persons with stroke and cognitive impairments, rehabilitation that incorporates cognitively focused and contextually relevant daily life activities is reasonable for improving global cognition, working memory, and executive functions.[17,18]
2b	B-R	4. In persons with stroke and cognitive impairments, integrated cognitive-motor training may be reasonable for improving global cognition and working memory.[19–23]

Synopsis

In patients with stroke with cognitive or memory impairments, technology-supported cognitive training that is supervised, moderate to high intensity, and tailored to deficit areas or adaptive to progress is superior to paper-and-pencil cognitive training for improving global cognition (ie, as assessed with brief, multidomain instruments), as well as attention and working memory.[24–32] The use of real-life simulation tasks and traditional cognitive tasks with these technologies yields similar results,[33] but training duration may matter.[29] Caregivers may feasibly deliver cognitive training, either in person[34–36] or via telerehabilitation.[37] Combining cognitive training with physical activity at any intensity (simultaneously or sequentially) may be superior to physical activity alone for improving global cognition, working memory, and delayed recall.[38–44] Additionally, integrated cognitive-motor training appears to improve global cognition and working memory.[23,45–48] Furthermore, rehabilitation that incorporates cognitively focused and contextually relevant ADLs not only improves independence with these activities, but also shows promise for improving global cognition, working memory, and executive function in small samples of patients with subacute stroke with cognitive impairments.[49,50] The benefits for persons with chronic stroke with cognitive impairments are unclear. Group memory skills training may support adoption of compensatory strategies to aid memory with everyday activities after stroke, but the impact on short-term or long-term memory, measured through patient-report or neuropsychological testing, is uncertain.[51–53]

Recommendation-Specific Supportive Text

1. Two systematic reviews with meta-analyses[24,25] and several RCTs[26–32] provide consistent and robust support for the superiority of technology-supported cognitive training for improving global cognition, attention, and working memory compared with conventional (eg, paper and pencil) cognitive training, when the technology-supported cognitive training is supervised, moderate to high intensity, and tailored to deficit areas or adaptive to progress. Technology-supported cognitive training includes the use of computer programs, interactive gaming, and VR programs.
2. Two RCTs reported that a combination of cognitive training and physical activity, either simultaneous or in sequence, was associated with greater improvements in attention, working memory, and executive function than physical activity alone.[38,39] The role of the intensity of combined cognitive training and physical activity interventions remains unclear. RCTs with small samples[40–42] suggest that a combination of cognitive training and moderate to vigorous aerobic exercise is superior to a combination of low-intensity cognitive and physical activities for improving global cognitive outcomes, attention, and working memory. However, 2 RCTs with larger samples[43,44] observed no differences between cognitive training with aerobic exercise versus low-intensity cognitive and physical activities for improving cognitive function in patients with chronic stroke.
3. Two RCTs compared rehabilitation using cognitively focused and contextually relevant everyday activities with conventional rehabilitation in patients with early and late subacute stroke. Both trials had 1 or more design limitations that may limit generalizability (eg, small sample size, cognition assessed with imprecise measurement instruments or a secondary outcome, missing data). Nonetheless, both studies reported significantly greater improvements in cognition, with 1 study reporting improvements in global cognition and working memory,[49] and both studies reporting improvements in executive functions.[49,50]
4. A systematic review and meta-analysis of 24 studies (n=889 patients with subacute stroke) reported that visuomotor training was associated with small but significantly greater effects on global cognition and working memory outcomes compared with interventions without visuomotor training or no training at all.[45] Additionally, 4 moderate-quality RCTs examined integrated cognitive-motor training using training tasks that challenge both cognitive abilities and volitional motor control (eg, drumming hands and stomping feet to a rhythm,[23] grasping and moving objects to assigned locations on an LCD screen,[47] cognitive training while balancing,[46] stepping with computerized gaming[48]). These trials each reported that integrated cognitive-motor training resulted in small but significantly greater improvements in global cognition and working memory compared with motor training alone or no training. Collectively, these studies suggest that integrated cognitive-motor training, which incorporates cognitively demanding goals while focused on visuomotor, limb, or whole-body movements, shows promise for improving selected cognitive outcomes.

Knowledge Gaps and Future Research

- Several additional nonpharmacological interventions have been studied but lack well-designed, adequately powered RCTs that incorporate batteries of precise and responsive cognitive outcome measurement instruments (see section 4.4) and carefully selected statistical analysis methods necessary to support clinical practice recommendations. At present, brief, multidomain screening instruments (eg, MMSE, MoCA) are frequently used as outcome measures in these trials, despite significant limitations with these instruments in measuring meaningful changes in cognition and memory. These interventions are listed in the points that follow.
- In persons with acute stroke, limited data suggest that continuous positive airway pressure therapy may be associated with better cognitive outcomes compared with no therapy[54–57]; however, small samples and design limitations prohibit strong conclusions.
- Traditional Chinese exercises, such as Baduanjin and tai chi, may be associated with improved attention, working memory, executive functions and delayed recall, in the short-term, but the persistence of these improvements after exercises cease is unclear.[58,59]
- Scalp acupuncture with high intensity (5–6 sessions per week over 8–12 weeks) may be associated with small improvements in poststroke global cognition[60–62] and short- and long-term memory,[62] but the clinical significance of these findings and limitations in the outcome measures used in these studies point to the need for future research.
- Mindfulness may be associated with improvements in poststroke attention and working memory, but it remains unclear.[63]

- Listening to vocal music may improve verbal memory and language.[64] Drumming using hands and feet while listening to music may improve working memory.[23] However, the benefits of music for improving working memory requires further research with larger, well-designed studies.
- To date, there are no conclusive findings with respect to diet or supplements for improving poststroke cognition or memory.[65]
- Simple and complex assistive technology devices have been widely studied among patients with acquired brain injury as compensatory strategies to support performance of daily life activities for people with cognitive and memory impairments.[66] However, these studies have had low representation of patients with stroke (<50%). Those studies that focus on patients with stroke examine feasibility and user experience. Therefore, additional research is needed to assess the effectiveness of assistive technologies for people with cognitive impairments after stroke.
- Several studies examine noninvasive brain stimulation (eg, tDCS, rTMS, intermittent theta burst stimulation (ICTB)) or neurofeedback in combination with cognitive training to improve cognition and memory after stroke. However, to date, none of these methods have FDA approval for poststroke cognition or memory.

6.2. Acquired Communication Disorders

Recommendations for Acquired Communication Disorders
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
Apragmatism		
2a	B-NR	1. In persons with stroke and apragmatism, a referral to speech-language pathology is reasonable to facilitate restorative or compensatory communication related to prosody, language understanding, and language use.[1–5]
Aphasia		
1	A	2. In persons with stroke and aphasia, a variety of speech and language treatment approaches should be administered to facilitate restorative or compensatory communication.[6–17]
1	B-NR	3. In persons with stroke and aphasia, supported communication training is recommended as a therapeutic complement to improve facilitation skills important to enhancing the communication of persons with aphasia.[18–21]
2a	B-R	4. In persons with stroke and aphasia, the administration of intensive aphasia treatment can be useful to facilitate restorative or compensatory communication.[22–31]
2a	A	5. In persons with stroke and aphasia, use of telerehabilitation is reasonable when face-to-face treatment is not possible or impractical to facilitate access to skilled speech-language pathology treatment.[32–37]

Recommendations for Acquired Communication Disorders (Continued)

COR	LOE	Recommendations
2b	B-R	6. In persons with stroke and aphasia, computerized treatment may be considered to supplement traditional aphasia treatments, implemented by a speech-language pathologist, and designed to provide restorative or compensatory therapy.[38–43]
2b	B-NR	7. In persons with stroke and aphasia, group treatment (eg, community-based treatment groups) may be considered to facilitate restorative, compensatory, and interpersonal communication.[44]
Hearing Loss		
1	B-NR	8. In persons with stroke and hearing loss, a referral to an audiologist for the assessment of hearing and auditory processing is indicated to evaluate and mitigate the impact of hearing impairment.[45–47]
2a	B-NR	9. In persons with stroke and hearing loss, amplification (eg, hearing aids) and communication facilitating strategies (ie, reducing background noise, maintaining face-to-face posture) are reasonable to reduce the impact of hearing loss.[48,49]

Synopsis

Acquired neurogenic communication disorders affect at least 30% of stroke survivors presenting with aphasia and apragmatism.[4,50] The reviewed literature related to aphasia consisted of 9 RCTs,[16,25,29,31,33,34,38,41,42,44] 4 systematic reviews,[6,30,31,40] 2 evidence or narrative reviews,[35,43] 1 Cochrane review,[37] 7 systematic reviews and meta-analyses,[8–10,12,13,28,32,36] and 7 studies that were observational or nonrandomized.[7,11,15,26,39,51] Treatment across studies yielding positive outcomes included utilization of phonological or phonomotor approaches,[11,16,51] multimodal therapy,[25] melodic intonation and music therapy,[8,10,12,32] group therapy,[44] and computerized/self-managed therapies.[7,11,25,41,43] There is no agreed-upon definition of intensive treatment, though generally, this accounts for 5 or more hours of speech-language treatment per week. Studies consistently show that telerehabilitation approaches can be used effectively to treat aphasia, particularly when face-to-face treatments are not available.[32–34,36,43] Scientific advances related to the treatment of poststroke language disorders largely focus on aphasia after left hemisphere stroke, with little focus on communication disorders after right hemisphere stroke. Apragmatism is a newly adopted term that describes acquired pragmatic language disorders primarily associated with right hemisphere stroke.[2] Research for the treatment of apragmatism is in its infancy when compared with aphasia treatment. Similar to assessment, clinicians must consider the impact of poststroke cognitive impairment when managing individuals with either aphasia or apragmatism.[52] Finally, hearing loss after stroke can occur, and the impact of communication should be carefully considered.[47]

Recommendation-Specific Supportive Text

1. Apragmatism has been operationally defined as an acquired language disorder that causes difficulty in understanding and conveying the meaning or intent of nonverbal (ie, gestures, facial expressions, vocal manipulations) and verbal language within a specific context. It is primarily associated with right hemisphere stroke, with recent efforts to establish a new International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) code because the cognitive-communication disorders ICD-10-CM code commonly associated with right hemisphere strokes does not capture the specific pragmatic language deficits. A diagnostically appropriate ICD-10-CM code can help drive increased clinical referrals for and the development of language-specific treatments, particularly given that treatment of apragmatism is in its infancy, with the current literature describing impacted language components[2] and its disabling effects.[5] The ASHA suggests a patient-centered therapeutic approach to establish[40] restorative, compensatory, or combination treatment and increased awareness of language deviances within various communicative contexts and across each domain of apragmatism.[53] Treatment to date, however, is largely focused on improving cognition and disorders of spatial neglect.[54] A single-treatment study outlines an explicit approach to feature training affective aspects of language and their meaning.[3]
2. A variety of treatments for individuals with aphasia have been deemed efficacious. A Cochrane review completed in 2016 offered strong evidence for the treatment of aphasia after stroke to improve functional communication, reading, writing, and expressive language.[17] Treatment approaches designed to improve aphasia outcomes, including phonological or phonomotor approaches,[11,16,51] multimodal therapies,[25] and melodic intonation and music therapy,[8–10,12,32] yielded positive outcomes for improving language outcomes. Therapies designed to target specific aspects of language include semantic feature analysis,[55] and verb network strengthening treatment.[56] Research and clinical practice approaches consistently highlight the need for individualized treatments that use a patient-centered approach[57] and target the specific needs of the client to enhance not only language recovery but also successful, effective, and efficient functional communication in a variety of settings.
3. In individuals with aphasia, there are established benefits to communication partner training, although there is considerable variation in its implementation. Communication partners are particularly valuable to individuals with aphasia to improve communication access and reduce social isolation and the frustration that emerges from lack of communication independence. The availability of communication partners also reduces the likelihood of perceived competence issues that individuals with aphasia frequently experience. For both familiar partners and health care professionals, successful communication partner training should overcome reduced confidence with implementation and value realization of familiar partners while fostering an understanding of existing skill capabilities and concomitant disorders of the persons with aphasia, both linguistic and cognitive.[19,58] Clinicians should be aware that recent changes to reimbursement offer opportunities to complete communication partner training.[58a]
4. Computerized treatment for aphasia continues to grow alongside technological advances. The self-administration aspect of computerized treatments offers individuals with aphasia greater accessibility to treatment, whether as a primary treatment focus or as an adjunct to in-person treatments. Computerized treatment also offers options for high-intensity and cost-effective treatments that extend beyond traditional behavioral treatment approaches. Computerized treatments primarily address specific skills, such as naming or word finding, and have limitations related to feedback and adjusting task difficulty, complexity, and specificity that is available when treatments are provided by speech-language pathologists. Recent reviews of the literature offer evidence that computerized approaches can be offered in clinical practice or home-based settings using computers, smart tablets, and other emerging technology.[40]
5. Telerehabilitation approaches to aphasia management service delivery increased dramatically during the COVID-19 pandemic. Studies have consistently shown that telerehabilitation can be utilized effectively when face-to-face treatments are not available or as an adjunct to face-to-face treatments to offer greater treatment intensity.[22,34,36,43] Although temporary, changes in third-party reimbursement supporting the use of telerehabilitation during the pandemic offered great insights into the usability and effectiveness as well as patient satisfaction with the approach. Coverage during the pandemic resulted in major expansions in the availability of services. Future research must be designed to identify the ideal situations for telerehabilitation use in aphasia, followed by large-scale advocacy efforts to ensure sustained reimbursement.[59]
6. Intensive treatment for aphasia provides patients with aphasia high doses of focused treatment, generally over shorter time frames, to improve language recovery and subsequently overall communication ability.[6,23,26,29,31] Experts in the field have

concluded that patients with aphasia should be offered "intensive and individualized" aphasia treatment to improve their overall communication.[18] Although studies have shown improved outcomes following intensive treatments for aphasia, particularly in overall functional communication,[34] the ideal intensity level and specific approach to high-intensity treatments remains unclear. Data from 448 patients in Germany from 2003 to 2020 were collected and analyzed, offering great insights into how intensive treatments might be used in routine clinical settings.[18] Improvements were noted in the early subacute, late subacute, and chronic phases of recovery. The study noted that time post onset, therapy dosage, and aphasia severity at treatment onset were predictors of treatment outcomes.[23]

7. Group treatment in a variety of settings has demonstrated functional improvement in communication[60] and community participation.[44] Group treatment offers benefits beyond language recovery, which include greater social interactions and opportunities to increase treatment intensity at lower cost. Implementation of group treatments can vary, including differences in the number of individuals engaged in group treatment and the overall focus of treatments.
8. Hearing loss after stroke is believed to impact all aspects of auditory functioning and is associated with gait and balance disorders.[47] Some persons with stroke experience sudden hearing loss after stroke. To date, few studies have explored the relationship between hearing loss and poststroke communication disorders. Therefore, the interaction between hearing disorders after stroke and poststroke language and communication has not been carefully considered despite the likelihood of auditory processing issues alongside traditionally impacted language. Some even suggest that sudden hearing loss may be a precursor for stroke, and clinicians treating persons with stroke should consider hearing assessments for all persons with stroke.[61]
9. The impact of hearing loss on everyday communication and rehabilitation can be lessened with amplification using appropriately fitted hearing aids and other auditory rehabilitation options.[62,63] In environments with multiple communication partners, modifications including reduced background noise (eg, turning off the television or radio, moving to a quiet room) can help persons with stroke with hearing loss better communicate.[64] Other strategies such as maintaining a face-to-face posture, ensuring good lighting, minimizing background noise, and optimizing visual cues (eg, lip movements, facial expressions) can also help patients with hearing loss after stroke.[65]

Knowledge Gaps and Future Research

- Substantial research has emerged related to the use of neurostimulation,[51,66–84] acupuncture,[85–93] CBT,[94,95] pharmacotherapy,[96,97] and artificial intelligence/VR.[42,98–103] The current literature has shown that neurostimulation approaches enhance aphasia recovery, communication ability, and mood when combined with traditional behavioral therapy for aphasia. Additional research and clinical practice guidelines are needed to support neurostimulation and alternative treatment approaches that accommodate and compensate for cognitive and linguistic deficits that decrease access and reduce quality of life and life satisfaction for persons with aphasia.
- Additional research is needed to explore the benefits and potential adverse effects of pharmacotherapy approaches. FDA approval for use with aphasia will be required for widespread clinical use.
- Additional research is needed to determine the best, ideal approaches to communication partner training for persons with aphasia that align with different clinical settings providing stroke care.
- Additional research is needed to understand best practices for the treatment of apragmatism after right hemisphere stroke.
- Additional research is needed to understand the influence and impact of hearing loss on the treatment of poststroke communication disorders.

6.3. Motor Speech Disorders: Dysarthria and Apraxia of Speech

Recommendations for Motor Speech Disorders: Dysarthria and Apraxia of Speech
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-NR	1. In persons with poststroke motor speech disorders, behavioral speech interventions are recommended to improve communication effectiveness.[1–5]
1	B-R	2. In persons with poststroke motor speech disorders, respiratory training is a beneficial adjuvant to traditional behavioral speech interventions to improve communication effectiveness.[6–9]
1	C-LD	3. In persons with poststroke motor speech disorders or who have a tracheostomy in situ, augmentative and alternative communication (AAC) devices and modalities should be used to supplement speech to improve communication effectiveness.[10,11]
2a	B-NR	4. In persons with poststroke motor speech disorders, computer or smartphone-based applications can be beneficial as an adjunct to traditional behavioral speech interventions to improve communication effectiveness.[12–17]
2a	B-NR	5. In persons with poststroke motor speech disorders and hypernasality, prosthetics can be useful to improve communication effectiveness.[18]

Recommendations for Motor Speech Disorders: Dysarthria and Apraxia of Speech (Continued)		
COR	LOE	Recommendations
2b	C-LD	6. In persons with poststroke motor speech disorders, telerehabilitation may be useful when face-to-face treatment is impossible or impracticable to improve communication effectiveness.[19,20]
3: No Benefit	B-R	7. In persons with poststroke motor speech disorders, nonspeech oral-motor exercises are not an effective adjuvant to traditional behavioral speech interventions to improve communication effectiveness.[21,22]

Synopsis

Motor speech disorders, including dysarthria and apraxia of speech, are common after stroke and could be an outcome of changes on respiration, phonation, articulation, resonance, and prosody, which in turn impact intelligibility, communication effectiveness, and participation. Behavioral speech therapy is the primary evidence-supported treatment for these disorders.[23] Systematic reviews suggest that task-specific behavioral interventions can improve speech intelligibility, articulatory precision, and respiratory-phonatory coordination for patients with dysarthria and apraxia of speech.[1–3,5] Adjunctive therapies may enhance outcomes when paired with behavioral treatment. Respiratory muscle training improves respiratory support and phonatory control, adding benefit for individuals with reduced breath support for speech.[6] Structured breath-support programs plus conventional therapy demonstrate reduced dysarthria severity when compared with conventional therapy alone.[7,9] Nonspeech oral motor exercises lack evidence to support or refute their benefit after stroke.[21,22] There is no consensus on the optimum amount, distribution, or variability of practice or the best type, frequency, and timing of treatment.

For individuals with limited natural speech, AAC systems, which range from low-tech boards to high-tech devices, provide effective supplemental communication options and support participation.[10,11,15] Technology-based therapy, including computer-based programs, tablet interventions, and smartphone-supported practice, has demonstrated feasibility and potential efficacy as an accessory to in-person treatment.[13,14] Telepractice delivers additional access and treatment continuity and can be considered as an appropriate service modality for neurologic speech disorders.[19,20] Together, these interventions form a comprehensive, patient-centered framework for restoring functional communication in adults with motor speech disorders after stroke.

Recommendation-Specific Supportive Text

1. Behavioral speech therapy is the foundation of management for motor speech disorders after stroke, including dysarthria and apraxia of speech. Several studies demonstrate that structured, targeted behavioral interventions directly improve speech intelligibility, articulatory precision, respiratory-phonatory coordination, and functional communication. For apraxia of speech, intensive articulatory-kinematic approaches such as Sound Production Treatment have demonstrated benefit, though they are influenced by practice structure and treatment intensity.[1,3]

   Behavioral speech treatment for dysarthria may have positive effects across speech subsystems, particularly when therapy incorporates task-specific speech exercises with clear therapeutic targets.[2,5]

   Respiratory and phonatory training, delivered through structured behavioral programs, can further enhance speech support for dysarthria, improving breath control and vocal quality.[6] Integrating culturally specific or structured breath-support methods, such as liuzijue qigong, has also demonstrated benefit when combined with conventional speech therapy.[7,9]

   Technology-supported behavioral therapy, including computer-based, tablet-based, or self-administered programs, may enhance access to specialty care and can supplement clinician-delivered interventions.[14,17]
2. Respiratory training is an important adjunct to traditional speech therapy for individuals with dysarthria after stroke, particularly when respiratory muscle weakness or impaired breath control contributes to reduced speech intelligibility and vocal intensity. Behavioral speech therapy alone can improve articulatory precision and phonatory control, but respiratory impairments often limit functional gains unless they are addressed directly through targeted respiratory strengthening or breath-support interventions. These benefits suggest that improved respiratory strength and coordination can enhance the effectiveness of speech-focused therapies.

   Additional trials support the use of structured breath-support programs alongside traditional therapy. Controlled studies of liuzijue qigong, an organized pattern of breathing and phonatory exercises, showed that when integrated with conventional speech therapy, patients exhibited greater improvements in respiratory control, vocal quality, and dysarthria severity compared with standard breathing exercises alone.[7,9] Other approaches, such as ventilator-assisted intermittent positive pressure breathing protocols, demonstrate feasibility and early evidence of benefit, offering an alternative method for strengthening respiratory support in dysarthric speakers.[8]
3. AAC devices provide essential support for individuals with motor speech disorders after stroke, particularly when dysarthria or apraxia significantly limits intelligibility or speech output. AAC systems, ranging from low-tech tools such as communication boards to high-tech, customizable devices, serve as important supplements or temporary alternatives to natural speech, enabling patients to express needs, participate in care decisions, and maintain

social connections. Evidence shows that AAC technologies can meaningfully enhance communication effectiveness and engagement for individuals with severe neuromotor impairments. For example, technology-supported AAC systems have been shown to facilitate communication, leisure engagement, and autonomy for individuals with profound motor limitations, demonstrating the potential for AAC to improve participation and quality of life.[10]

Low-technology AAC options are often particularly important in acute or intensive-care settings, where fatigue, medical complexity, or environmental barriers may limit speech production. A mixed-methods systematic review found that low-tech AAC tools improved communication success and patient experience in intensive care, while also being perceived as usable and acceptable by both patients and health care providers.[11] These findings underscore the practicality and accessibility of AAC solutions early in recovery.

4. Computer- and smartphone-based applications are increasingly valuable adjuncts to traditional speech therapy for poststroke motor speech disorders, offering additional practice opportunities, enhanced accessibility, and potential gains in treatment intensity. Early work examining e-learning–based speech therapy platforms demonstrated their feasibility for capturing within-subject changes in speech intelligibility, highlighting the potential for digital tools to support structured, repeatable practice outside the clinic.[12] Building on this foundation, mobile tablet–based rehabilitation programs have shown promise for delivering communication exercises in acute-care settings.[13]

   Digital tools have also been evaluated for specific motor speech disorders. A randomized controlled crossover trial found that self-administered computer therapy improved speech production in individuals with apraxia of speech, demonstrating that independent, technology-supported practice can meaningfully supplement clinician-guided treatment.[14,15]

5. Prosthetic intervention is an important option for managing velopharyngeal impairment and associated hypernasality in adults with dysarthria following stroke, particularly when behavioral therapy alone does not sufficiently improve resonance. The 2025 systematic review by Spencer and colleagues provides the most comprehensive synthesis to date on management approaches for liuzijue qigong in adults with neurologic speech disorders, highlighting that prosthetic devices such as palatal lifts or palatal obturators can meaningfully improve speech resonance and intelligibility in appropriately selected patients. These devices mechanically support or reposition the soft palate and velopharyngeal structures, reducing excessive nasal airflow during speech and enhancing acoustic output.[18]

6. Telerehabilitation is an increasingly important mode of service delivery for speech therapy in adults with motor speech disorders after stroke, expanding access to care while maintaining treatment quality and continuity. Early evidence synthesized by Cherney and van Vuuren demonstrated that speech-language interventions delivered through telepractice, including synchronous videoconferencing and virtual-therapist systems, can produce meaningful improvements in speech production, intelligibility, and communication participation in individuals with acquired neurologic speech and language disorders. Their review highlighted that telerehabilitation supports high treatment intensity, improves adherence through home-based practice, and enables monitoring of speech performance in real-world environments that may not be accessible in a clinic.[19]

   Current professional guidance reinforces the viability and acceptability of telepractice. According to the ASHA's Telepractice Portal,[20] telehealth delivery of speech-language pathology services is considered clinically appropriate when it meets the same standards of care as in-person treatment, with strong evidence supporting its use for adults with dysarthria and apraxia of speech. Telepractice platforms allow clinicians to provide behavioral speech therapy, respiratory training, AAC support, and caregiver education remotely, ensuring care continuity for individuals with mobility limitations, geographic barriers, or limited access to specialized services.[20]

7. Nonspeech oral motor exercises (NSOMEs), such as tongue wagging, lip stretching, or isolated jaw movements, have not been shown to improve speech production in adults with motor speech disorders after stroke. These exercises target strength or movement of orofacial structures outside the context of speech, but evidence indicates that they do not translate into meaningful gains in intelligibility, articulation, or functional communication. A comprehensive evidence-based review found no compelling support for NSOMEs as an intervention for speech disorders; across available studies, improvements in speech outcomes were minimal or absent, and any gains were not clearly attributable to the exercises themselves.[21] The authors concluded that speech is a highly specialized, task-specific motor skill, and nonspeech movements do not adequately engage the complex, coordinated neuromuscular patterns required for speech production.

   Subsequent research in poststroke dysarthria reinforces these findings. A randomized feasibility trial examining NSOMEs in stroke survivors demonstrated limited benefit, with no consistent or clinically meaningful improvements in speech measures compared with control conditions.[22] Participants tolerated the exercises, but the study highlighted that NSOMEs did not serve as an effective rehabilitation strategy for restoring speech function.

Knowledge Gaps and Future Research

- More research is needed to determine ideal frequency, duration, and cumulative dose of behavioral speech therapy for maximizing gains in dysarthria and apraxia of speech.
- Studies are needed to identify patient-level characteristics (eg, lesion location, severity, cognitive status) that predict who benefits most from specific motor-speech interventions.
- Although respiratory training shows promise, research is needed to define optimal protocols, timing, and how best to integrate respiratory and speech exercises into a unified treatment plan.
- Large-scale, controlled trials are required to determine the effectiveness of smartphone apps, computer-based programs, and telepractice compared with traditional therapy, and to identify which patients benefit most from digital delivery.
- Limited data exist on long-term functional communication, user satisfaction, and device sustainability for AAC systems used after stroke.
- While prosthetics and behavioral approaches are used clinically, further research should clarify which techniques best target hypernasality in stroke-related dysarthria.
- Noninvasive neuromodulation, such as tDCS, has been the focus of some recent clinical trials in poststroke motor speech disorders,[24,25] but there is no current FDA clearance for this intended use.
- More rigorous studies are needed to define the boundaries of task specificity in motor-speech rehabilitation and to rule out any potential roles for nonspeech oral-motor activities.
- Future trials should incorporate ecologically valid, patient-centered outcomes that reflect communication success in daily life rather than laboratory or clinic-based measures alone.

6.4. Spatial Neglect

Recommendations for Spatial Neglect
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendation
2a	A	1. In persons with stroke and spatial neglect, it is reasonable to use visual eye movement training approaches such as optokinetic stimulation or saccadic/smooth pursuit eye movement training to improve visual-spatial impairment.[1–6]
2a	B-R	2. In persons with spatial neglect after stroke, mirror therapy in combination with conventional therapy is reasonable to improve functional independence.[7,8]

Recommendations for Spatial Neglect (Continued)

COR	LOE	Recommendations
2b	B-R	3. In persons with spatial neglect after stroke, prism adaptation therapy (visual shift >10 degrees) in combination with conventional therapy may be reasonable to improve long-term spatial impairment and functional independence, and reduce fall risk.[9–26]
2b	B-NR	4. In persons with spatial neglect after stroke, it might be reasonable to use limb activation or VR to reduce spatial impairment.[26–31]
3: No benefit	B-R	5. In persons with spatial neglect after stroke, galvanic vestibular stimulation is not useful to enhance independence in daily life.[27,28]

Synopsis

Spatial neglect (hemi-inattention) is asymmetric reporting, responding, or orienting to 1 side of space after a brain lesion, causing functional disability. It causes perceptual, awareness, and movement-related errors and tremendous poststroke personal and social cost.[29] Spatial neglect affects at least half of survivors in the months after stroke,[30] but is underdiagnosed and undertreated (4.9% and 2.9% of stroke patients[30]). The diverse brain networks associated with spatial neglect give rise to dissociable symptoms; thus, spatial neglect is a syndrome rather than a disorder of a single type of information processing.[31,32] Clinically meaningful and person-centered spatial neglect rehabilitation requires clinicians to consider the brain mechanism of targeted symptoms and to implement specific, defined, interprofessional care protocols.[4]

Recommendation-Specific Supportive Text

1. Optokinetic stimulation, saccadic and smooth pursuit eye movement training: 4 small RCTs and 2 systematic reviews[1–6] supported the value of visual eye movement training—arguably a core component of implementation of the first systematically implemented spatial neglect intervention, visual scanning training.[33,34] Spatial impairment improved after 15 sessions of optokinetic/cuing training;[1] spatial impairment improved on follow-up, though not immediately after 7 sessions of optokinetic/hemifield patching training.[5] Reported daily function improved after 20 sessions of smooth pursuit training;[3] both oculomotor and spatial impairment, and reported daily function, improved after 20 sessions of saccadic eye movement training combined with visual scanning exercises and task-specific training;[6] and spatial impairment and daily life function improved after saccadic eye movement training, with visual scanning exercises.[4] Two studies demonstrated training effects versus active control;[1,3] 2 compared eye movement training plus task-specific training, with task-specific training alone.[5,6] A systematic review[4] examined 5 studies

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of smooth pursuit eye movement training immediately and after a few weeks, with some improvement in spatial performance on daily life function tasks. It also concluded that smooth-pursuit eye movement training improves spatial impairment in patients in the chronic phase of stroke recovery. Another systematic review of 9 randomized and nonrandomized studies, including a total of 147 participants,[2] concluded that the best eye movement training evidence suggested smooth pursuit eye movement training (5 sessions and 20 sessions in 2 studies) could improve spatial impairment tasks. However, there was also a smaller beneficial effect of reflexive saccadic eye movement training with optokinetic stimulation.

Limitations of new research include lack of information on feasibility and sustainability of eye movement training programs given the potential importance of using specific labor-intensive methods.[5] New studies did not evaluate dose-response information, nor patient characteristics predicting optimal benefit.

2. In sessions of prism adaptation therapy, persons with stroke wear goggles with mounted wedge prisms. An occluder blocks their ability to view their own arm as they make repeated movements (pointing, crossing out lines). Multiple brief sessions (often, 10) are carried out over consecutive days or weeks; prisms are worn only during training sessions. A systematic review reported that prism adaptation therapy improved spatial impairment on visual search.[12] Three systematic reviews with meta-analysis reviewed 8, 7, and 10 RCTs,[15,17,26] reporting that prism adaptation therapy resulted in improved spatial impairment performance on tasks correlated with daily life ability. An RCT conducted in African patients[23] reported that prism adaptation therapy improved both spatial impairment and functional performance tasks, and that better cognitive ability predicted better treatment response. Two RCTs suggested that the beneficial effects of prism adaptation therapy can last for months,[19,24] A review examining only the impact of prism adaptation therapy on daily life function reported a benefit, with larger effects in studies of better methodologic quality.[19] Three RCTs studied feasibility of prism adaptation therapy, concluding that it is feasible and acceptable.[10,13,19] Two of these studies were underpowered and reported no treatment effects; however, 1 study[19] reported greater functional gains after prism adaptation therapy compared with usual care in patients with more severe spatial neglect. An observational, real-life, nonrandomized retrospective study suggested that prism adaptation therapy might be associated with reduced fall risk.[11]

Prism adaptation therapy effect modifiers include frontal disconnection/spatial neglect subtype,[14,16] severity,[13] time after stroke, method of administration of prism adaptation therapy, and treatment dosage/frequency.[9] An RCT[22] and 2 meta-analyses[18,21] reported that prism adaptation therapy was not superior to the control treatment; however, these studies did not consider effect modifiers and used different inclusion and quality criteria than reviews that found positive effects.

3. Mirror therapy is an approach using a mirror placed between the arms or legs that reflects the moving, less-affected limb. Regarding the mirror provides the patient with the illusion of movement in the affected limb. Two systematic reviews[7,8] evaluating the effect of mirror therapy on spatial neglect and pusher syndrome. They found 3 RCTs supporting the use of mirror therapy using a mirror mounted either in a frame or box, in protocols of 3 to 5 weeks.
4. Limb activation therapy,[35] involves improving spatial neglect through moving the contralesional limb(s) (neglected side) or holding a static posture with that side of the body. A systematic review examined its administration with a cuing intervention,[4] and a systematic review with a meta-analysis evaluated using a robotic device to activate that side of the body.[36] Both publications concluded that the intervention can improve spatial impairment. CIMT, though intended to improve motor function and not spatial-motor impairment, was also shown to improve spatial performance on functional tasks in an RCT[37] and to improve spatial impairment in a systematic review.[4]

VR interventions are diverse in their design, equipment, and administration; however, they involve computer-based visual-motor interaction. Immersive VR can utilize goggles or other controlled viewing,[38] or VR can be semi-immersive or nonimmersive in free vision.[39,40] Two small RCTs[38,39] and a systematic review[40] reported improvement in laboratory spatial tasks or in spatial impairment, and the systematic review reported 4 of 5 studies with improvement in ADLs or functional performance relevant to daily life.[40]

5. Galvanic vestibular stimulation stimulates the vestibular system via electrical current applied to the mastoid, stimulating the inner ear and the cortical vestibular system. A small RCT[27] and a systematic review with meta-analysis showed no beneficial treatment signal for this intervention on spatial impairment,[28] even considering different electrode applications.

Knowledge Gaps and Future Research

- Despite small studies, it is very likely that the issue in spatial neglect rehabilitation research with variability of results and replicability could be addressed by defining patient-based treatment effect modifiers. Targeting treatments to age (children[41]); racial/ethnic and social groups;[32] and spatial neglect subtypes[14,31,42–44] requires studies intended to inform stratification. Adverse effects on spatial neglect of therapies such as treatments for other disorders will also improve the ability to detect spatial treatment effects. Thus, coordinated efforts in real-world settings may be needed to develop larger-scale studies.

- There is more information needed on pharmacological approaches to spatial neglect,[45] effective combined treatment of visual field deficits and spatial neglect, and the relative benefits of other stroke motor recovery interventions on patients with spatial neglect.[46,47] Studies needed: real-life spatial neglect treatment applicability and feasibility; neuroanatomic/phenotypic subgroups affecting treatment assignment; the effect of spatial neglect treatment to reduce adverse health outcomes such as home accidents, delirium, rehospitalization, and loss of driving ability; and interventions effective to reduce the adverse impact of spatial neglect on care partners and caregivers.
- In addition, the treatments below merit further study:
  - Sensory approaches: acupuncture[48–50] and sound[51]
  - Body-somatic treatments: caloric vestibular stimulation and vestibular rehabilitation,[28] therapeutic body positioning[52]
  - Noninvasive brain stimulation (rTMS and tDCS).[52–63]

7. TRANSITIONS IN CARE AND COMMUNITY REHABILITATION

7.1. Ensuring Medical and Rehabilitation Continuity Through the Rehabilitation Process and Into the Community

Recommendations for Ensuring Medical and Rehabilitation Continuity Through the Rehabilitation Process and Into the Community
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
2a	B-R	1. In persons hospitalized with stroke, individualized discharge planning in the transition from hospital to home can be useful for physical function, self-management, and patient experience.[1–5]
2b	C-LD	2. For persons hospitalized with stroke, alternative methods of continuity care using telehealth might be considered to deliver transitional care services from hospital to home.[6,7]

Synopsis

The transition period from hospital to home is a highly vulnerable time for patients after stroke. There may be new physical, cognitive, or emotional changes related to stroke, newly diagnosed or destabilized medical conditions, and safety concerns. In the home setting, self-management of chronic medical problems and stroke risk factors often requires new medications, additional testing, and outpatient follow-up, in addition to navigating a new "normal." Several studies have demonstrated the importance of close follow-up after hospitalization for stroke to improve outcomes and decrease readmission rates.[1,3,4,8–11] However, it is well recognized that the continuum of care after stroke hospitalization is often filled with delays and a variety of barriers in accessing care. This problem is even more glaring in low-resource settings.

Recommendation-Specific Supportive Text

1. Discharge planning specific to the transition from hospital to community should begin in the hospital and be individualized to address health literacy, sociodemographic vulnerabilities, and stroke-specific needs. One recent systematic review of 9 RCTs looked at the effectiveness of various models of primary care–based follow-up after stroke. The studies included interventions using stroke support workers, care coordinators, or case managers. Because of the wide variability of the methodological quality of the studies, interpretation was limited. The authors noted that although patients and caregivers receiving follow-up were generally more satisfied with some aspects of communication and had a greater knowledge of stroke, there did not appear to be any gains in physical function, mood, or quality of life compared with those who did not.[12] Another systematic review examining transitional care models after stroke or myocardial infarction showed that hospital-initiated transitional care could improve some outcomes in adults hospitalized for stroke or myocardial infarction.[13] Although not specific to stroke, a 2012 Cochrane study to determine the effectiveness of discharge planning for patients moving from an acute hospital to a home setting evaluated the results of 24 RCTs comparing individualized discharge plans with routine discharge care that was not tailored to the individual patient. Using data from 8098 patients, the investigators found that hospital length of stay and hospital readmissions were "statistically significantly reduced for patients admitted to hospital with a medical diagnosis and who were allocated to discharge planning (mean difference in length of stay, −0.91 [95% CI, −1.55 to −0.27],10 trials; readmission rates RR, 0.82 [95% CI, 0.73–0.92], 12 trials)." For older patients

with a medical condition, there was no significant difference between groups with respect to mortality (RR, 0.99 [95% CI, 0.78–1.25], 5 trials) or being discharged from hospital to home (RR, 1.03 [95%CI, 0.93–1.14], 2 trials). The authors concluded that a "discharge plan tailored to the individual patient probably brings about reductions in hospital length of stay and readmission rates for older people admitted to hospital with a medical condition" but that the impact of discharge planning on mortality, health outcomes, and cost remained unclear.[14] The COMPASS Study was a cluster RCT to determine if a comprehensive postacute stroke model improved outcome after hospitalization for stroke in a statewide system. There was no difference in functional outcome between the intervention and control group—the primary aim of the study. It should be noted that only 35% of patients at intervention hospitals received the series of visits, a major study limitation. For patients who have had a stroke and are being discharged from acute care, the discharge planning should include rehabilitation professionals who can identify long-term needs and help organize the provision of those services.

2. Telemedicine should be considered as a modality to increase access to follow-up stroke care, especially during times of physical limitations and driver restrictions that may preclude easy access to in-person care. The complexity of the US health care system is another potential threat to the continuum of stroke care and puts patients at even higher risk for poor outcomes after discharge. Telehealth use has rapidly increased in the United States, affording the possibility of increased access to care, decreased time to care, and reduced health care costs.[15] Telehealth, defined as "the delivery of health care services where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries…"[16,17] For persons with stroke, multiple physical, cognitive, and regulatory issues preclude easy return to the health care system for follow-up after stroke. Use of telehealth platforms has demonstrated the potential to facilitate access to specialty stroke care and rehabilitation in the early poststroke period. Additionally, the use of such technologies allows for the involvement of care partners to promote improved self-management, regardless of how remote they might be to the recently discharged patient. These technologies can be used for long-distance counseling, problem solving, educational sessions, certain rehabilitative sessions, as well as for transmitting critical data such as blood pressure readings, weight, or laboratory results.[18]

Transitional care programs enhanced by the use of telehealth technologies in the transition from hospital to community should be considered to minimize low-value health system encounters, reduce complications, and improve long-term outcomes after hospitalization for stroke.[19]

Knowledge Gaps and Future Research

- Lack of standardized approach to studies of transitional stroke care, including the establishment of comprehensive and standardized outcome measures
- Limited evidence of long-term effectiveness
- Investigation specific to access to care and technology in patients with stroke with risk factors specific to social determinants of health
- Inadequate care partner support embedded in stroke transitional care programs[20]

7.2. Caregiver Engagement and Support

Recommendations for Caregiver Engagement and Support
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
2a	B-R	1. Active and intentional engagement of caregivers of persons with stroke as early as possible and throughout rehabilitation can be beneficial to improve knowledge about stroke, mental health, and caregiver burden.[1–6]
2a	B-R	2. For persons with stroke, involving caregivers in education and training using teach-back about care and rehabilitation activities can be beneficial to improve patient and caregiver outcomes such as experience of care, ADLs, and mobility.[6–10]
2a	B-R	3. For caregivers of persons with stroke, after acute care discharge, longitudinal participation in a tailored caregiver-focused, multicomponent psychosocial or psychoeducational intervention can be beneficial to improve caregiver mental health, burden, and/or family functioning.[6,11–13]

Synopsis

Nationally representative data suggest that 5% of US caregivers provide care to an individual whose primary health concern is stroke, resulting in approximately 2.7 million stroke caregivers.[1]

Consistent reports of increased social support (ie, practical, informational, emotional, and relational support), particularly from a family caregiver, are associated with improved stroke survivor outcomes.[2,3] Caregivers also provide other forms of help, such as assistance with ADLs and IADLs, and physical assistance; however, some caregivers experience negative mental health outcomes related to caregiving, and many report significant unmet information and support needs throughout the continuum of care and rehabilitation, which can be associated with lower physical function in stroke survivors.[4,5] Lower physical function is associated with increased unmet needs for support of the caregiver. Many other sections of this guideline include recommendations that support inclusion of caregivers in rehabilitation-related efforts. This section specifically addresses recommendations to enhance both patient and caregiver outcomes when caregivers are engaged through intentional, dyadic, and caregiver-focused programs.

Recommendation-Specific Supportive Text

1. Dyadic studies that include both the patient and caregiver are heterogeneous in both intervention design and outcomes measured. In a systematic review of stroke family caregiver and dyadic interventions, 8 fully powered trials demonstrated improvements in stroke survivor and caregiver outcomes.[6] Similarly, an updated Cochrane review examined differences in passive (eg, using educational materials only) versus active (eg, using demonstrations, meetings and phone calls) information engagement and found that active methods promoted improved stroke survivor and caregiver outcomes, including mental health outcomes.[7] Additionally, several reviews examined telerehabilitation and technology-based interventions and consistently demonstrated improvements in stroke survivor knowledge and mental health outcomes.[8–11] One meta-analysis of 15 trials including informal caregivers of persons with stroke revealed that technology-based interventions with structured educational programs significantly reduced depressive symptoms.[9]
2. Several trials have specifically focused on teaching caregivers skills to improve patient rehabilitation outcomes. One trial tested a caregiver-mediated, home-based intervention that improved physical functioning in patients but did not reduce caregiver burden.[12] Another trial evaluated a minimal dose task-oriented circuit training program that actively engaged the caregiver; the intervention significantly improved physical functioning of the patient.[14] Caregivers who were randomized to receive a home-based training program to improve oral care practices for stroke survivors demonstrated improved knowledge, self-efficacy, and oral care behaviors compared to controls.[13] Critical to successful education and training in these programs was ensuring caregivers learned the skill through return demonstration. One study focused on the modality of return demonstration, trained family caregivers using video and teach-back by the caregiver; the teach-back group significantly improved caregiver care ability, and motor function and psychological status of stroke patients in a small, randomized trial.[15]
3. Many caregiver-focused multicomponent, psychosocial, and/or psychoeducational interventions and dyadic interventions, which include caregiver-focused components have been described in the literature.[6,16–18] Despite several small pilot trials and some mixed results, meta-analyses showed intervention-favoring effects on caregiver burden in 7 trials of multicomponent interventions.[16,17] Psychoeducational interventions improved family function in a meta-analysis of dyadic interventions that focused on caregiver needs in addition to patient needs. Overall, recommendations for caregiver-focused programs suggest the need for assessing caregiver needs and tailoring components to address needs[6]; however, the modality of delivering these programs may vary. Face-to-face, telephone, and telehealth/video-conferencing were used in successful caregiver-focused programs.[6]

Knowledge Gaps and Future Research

- Heterogeneity of intervention components and outcome measures limits effective comparability of caregiver and dyadic interventions. Future comparative effectiveness research should be considered to understand the most impactful components and the differential benefit on patient and caregiver outcomes.
- Scalability of caregiver-focused support through health systems or collaboration with community organizations (eg, Area Agencies on Aging) has not been examined in larger-scale implementation and pragmatic trials.

7.3. Referral to Community Resources

Recommendations for Referral to Community Resources
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	C-LD	1. For persons with stroke and their caregivers, individually tailored information about and referrals to up-to-date community resources should be provided throughout the continuum of care to facilitate access to such services.[1–3]
2a	B-R	2. For persons with stroke, interactive education (such as the teach-back method or 2-way communication) with follow-up can be beneficial to improve stroke survivor knowledge and reduce anxiety and depression.[4]
2a	B-NR	3. For persons with stroke, administration of the Post-Stroke Checklist (PSC) can be useful to identify stroke-related health problems and inform individualized referrals.[5–8]
2a	B-NR	4. For persons with stroke, referral to self-management or lifestyle intervention programs can be useful to improve stroke outcomes.[9–11]
2b	B-R	5. For persons with stroke and caregivers, technology-based stroke health education may be considered to improve stroke knowledge.[12–17]

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Synopsis

A successful transition from hospital to home following stroke requires a careful and individualized assessment of both patient and caregiver needs, matched with accessible formal and informal resources. During transitional periods, persons with stroke and caregivers report challenges such as poor communication with health care providers, fragmented coordination of care, limited preparedness for discharge, difficulty accessing rehabilitation and specialty services, and inadequate emotional, social, and informational support.[1–3] Referral to appropriate community resources may help address the needs and priorities of the patient and caregivers. The process should be individualized and consider emotional, informational, and logistical concerns.[2] Formal referrals may be necessary for services such as skilled rehabilitation or other clinical services. Informal resources may include community-based organizations, volunteer groups, not-for-profit agencies, or government-supported programs. Table 8 outlines examples of resources across diverse domains that could be considered based on individualized assessment. Patient and caregiver needs often evolve throughout the recovery process, making ongoing assessment and follow-up essential to identify and address unmet needs and improve overall quality of care.

Recommendation-Specific Supportive Text

1. A large systematic review including 51 qualitative studies with metaethnography found that persons with stroke and their informal caregivers often experience poor communication, fragmented care, and inadequate emotional and practical support from primary and community health care services.[2] This synthesis highlights a need for more integrated and individualized care. A second systematic review including 24 quantitative studies with metasynthesis identified 4 broad categories of unmet needs of persons with stroke and their caregivers: (1) disease-related information, (2) participation and physical recovery, (3) social-environmental resources, and (4) emotional support.[1] Taken together, there are multiple opportunities to address these gaps in care. However, evidence for interventions and approaches to improve access to resources that may address unmet needs after stroke is limited. A systematic review of 10 studies addressing poststroke access to social services or community resources described various approaches such as education, referral services, and navigation assistance that generally benefitted participants, though heterogeneity in study design and outcome measures limited clear interpretation of efficacy.[3]

Table 8: Examples of Community Resources and Referrals

Domain	Examples of services, supports, or referrals
Rehabilitation services	Physical therapy, occupational therapy, speech-language therapy, neuropsychology, community centers, home rehabilitation guides
Vocational support	Job retraining, supported employment, workplace accommodation, local or state programs, ADA counseling, online job boards, disability employment networks
Driving and transportation services	Driving rehabilitation, adaptive equipment evaluation State departments of motor vehicles, disability transportation
Social support	Stroke survivor support group, caregiver support, mental health counseling, peer-led community groups, online forums, faith-based organizations, AHA/ASA Stroke Support Group Finder
Leisure and recreation programs	Adaptive sports, art or music therapy, community center classes, therapeutic recreation specialists, hobby clubs Local or state parks and recreation programs, public library programs
Home support and respite	In-home respite, adult day programs, hospice respite, volunteer respite services, Meals on Wheels, local and state food banks, community volunteer programs, local not-for-profit services Local or state departments of aging resources
Financial aid and housing	Housing assistance programs, benefits counseling, financial planning, Medicaid HCBS waiver programs, insurance navigation information
AD and technology	Durable medical equipment, mobility aids, communication devices, home modifications, technology and digital literacy education and training, telehealth support
Education and navigation	Community health workers, social workers, workshops or community center education classes, resource guides Online education sources: AHA/ASA, World Stroke Organization, Brain Injury Association of America
Legal and Advocacy	Disability rights organizations, legal aid for housing/employment, patient advocacy groups
Wellness, nutrition, and self-management	Dietitian referral, community classes, education materials, self-management programs or workshops, recovery coaching, online modules, peer mentoring
Local, State, Federal, and National Resource Suggestions: National: American Heart Association/American Stroke Association Website Federal: Centers for Medicare & Medicaid Services State: Departments of aging, departments of health, departments of transportation/motor vehicles Local: Community centers, faith-based organizations, not-for-profit organizations, volunteers	

AHA/ASA indicates American Heart Association/American Stroke Association; AD, assistive devices; and HCBS, home and community-based services.

2. Access to relevant stroke-related information has been identified as a persistent knowledge gap for both persons with stroke and their caregivers.[1] To actively participate in decision-making and effectively manage the long-term effects of stroke, individuals require timely, accurate, and appropriately delivered information. Importantly, it is not only the content of the information that matters, but also the method of delivery. A Cochrane review of 33 studies, most of which were randomized designs, categorized educational interventions into "active" and "passive" interventions, where active interventions included purposeful interaction with subsequent opportunities for clarification and reinforcement, such as use of the teach-back method; 2-way communication allowing the participant to assimilate the information and ask questions; and a follow-up plan for reinforcement, clarification, or consolidation. In the meta-analysis, active interventions improved stroke survivor knowledge about stroke and slightly reduced stroke survivor anxiety and depression compared with controls.[4]
3. The PSC was developed by the Global Stroke Community Advisory Panel to standardize long-term stroke care by helping clinicians identify stroke-related problems and guide referrals to appropriate resources aimed at improving quality of life. Endorsed by the World Stroke Organization, the PSC is available online in 9 languages.[18] In an early pilot study, the PSC administered to persons with stroke from 8 months up to 5 years after stroke was feasible and acceptable for patients and clinicians.[8] Further observational studies demonstrated the PSC's utility in estimating the prevalence of stroke-related health problems reported in up to 95% of cases, and facilitating multidisciplinary referrals in 85% of cases.[7] At the 3- and 12-month follow-up, stroke-related health problems decreased but were still present in two-thirds of patients.[6] Additionally, the PSC domains of mood, cognition, social needs, and caregiver burden correlated with validated clinical measures, indicating promise as a comprehensive screening tool.[5]
4. An umbrella review examining behavior change and self-management interventions to reduce stroke risk included 15 systematic reviews with meta-analyses that varied in methodological quality, spanning a variety of secondary prevention outcomes (mortality/ morbidity, medication adherence, lifestyle behaviors, psychological outcomes, and physiological biomarkers).[11] Overall, there was no strong evidence for effects of such interventions on stroke recurrence or mortality. Evidence was strongest for multimodal interventions increasing physical activity and reducing cardiac events.[11] A Cochrane review of self-management interventions in community-dwelling adults with stroke with meta-analysis showed that such programs improved quality of life and self-efficacy compared with usual care.[10] A systematic review with meta-analysis of lifestyle interventions focusing on behaviorally modifiable risk factors demonstrated a significant reduction in systolic blood pressure but found no significant effect on other outcomes, including cardiovascular event rate and mortality.[9] Sections 5.8, "Lifestyle Modification and Management" and 7.6, "Recreational, Leisure, and Social Activity Participation" describe individual components of lifestyle, behavior change, and self-management interventions in more detail. The AHA's "Life's Essential 8" describes key measures for improving and maintaining cardiovascular health and can be used as a reference for patients and clinicians to guide behavior change and self-management.[19]
5. There is growing interest in the use of technology-based educational strategies to support persons with stroke. A systematic review of 10 studies evaluating such modalities found that all studies reported a positive effect on at least 1 primary outcome measure. However, the outcome measures varied widely, and none of the studies used the same technology, leading authors to conclude that more evidence is needed to determine the effectiveness of these approaches in improving stroke knowledge and self-management.[13] Similarly, a systematic review of self-directed technology interventions available "off the shelf," including computer programs, websites, and mobile phone applications, found that 15 of the 17 included studies reported at least 1 positive primary outcome, including participant acceptability, again with high heterogeneity.[14] In individual studies, personalized video education improved patient and caregiver satisfaction and sustained stroke knowledge at 90 days.[12] A large RCT (n=310) using a mobile video app found reduced stroke-related mortality in the intervention group, but not risk factor control.[15] Another RCT (n=63) found increased awareness of stroke risk factors with a mobile app, though knowledge scores and quality of life were not significantly better than traditional education.[16]

Knowledge Gaps and Future Research

- There is a need for more rigorous study designs to better assess the effectiveness of interventions aimed at improving access to community resources for patients with stroke and caregivers. Outcome measures must be consistent to enable comparison across studies.

- The effectiveness of technology-based education on a variety of long-term outcomes is unknown.
- The application of the PSC in United States settings is limited. Further research is needed about how to facilitate PSC implementation in the US.
- There is limited high-quality evidence describing the impact of peer support groups for persons with stroke, though social isolation is described as an unmet need.

7.4. Community Rehabilitation and Telerehabilitation

Recommendations for Community Rehabilitation and Telerehabilitation
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	A	1. In persons discharging from hospital with recent stroke, ongoing community- or home-based rehabilitation is recommended, when feasible, to achieve functional goals.[1]
2a	B-R	2. For persons living at home after stroke, home-based multidisciplinary rehabilitation is a reasonable alternative to clinic-based rehabilitation to achieve functional goals in mobility, self-care, and cognitive/communicative function.[2–6]
2a	B-R	3. For persons living at home after mild to moderate stroke, telerehabilitation therapies are reasonable alternatives to in-person therapies when access to these in-person therapies is limited or absent.[7–11]
2a	C-LD	4. For persons with mild to moderate stroke, participation in community-based exercise programs can be useful to improve strength, mobility, and cardiovascular health.[12–16]
2b	C-LD	5. In persons with stroke, coordinated education, therapy, and support services during and through the transition from hospital to home may be reasonable to improve stroke survivor self-efficacy, functional ability, and quality of life.[17–21]

Synopsis

Over recent decades, the average length of acute hospital stays for persons with stroke in the US has decreased to approximately 4 to 6 days, with inpatient rehabilitation that usually follows acute hospitalization typically lasting 10 to 14 days.[22] Despite this shortened timeline, recovery of upper limb function and gait often continues for 2 to 6 months poststroke.[23,24] Therefore, access to community-based rehabilitation services is essential to support ongoing functional recovery. While hospital or clinic-based outpatient rehabilitation can serve individuals living at home, barriers such as transportation challenges and limited regional availability may restrict access.[25] Alternative community-based options, including home health services, telerehabilitation, and neighborhood exercise programs tailored for persons with stroke, can help individuals achieve functional goals.

Recommendation-Specific Supportive Text

1. Many persons with stroke discharged directly from acute stroke units or following postacute rehabilitation hospitalization often experience mild to moderate residual impairments. Evidence from studies on ESD, as reviewed in section 2.1, indicates that community rehabilitation is effective for individuals with ongoing moderate disability to help them achieve meaningful functional recovery and to avoid a return to institutionalized care.[1]
2. Home-based multidisciplinary rehabilitation services can effectively support stroke recovery, particularly when strong family or caregiver involvement is present. These services are comparable to hospital or clinic-based rehabilitation in achieving functional goals. A meta-analysis of 49 RCTs comparing home-based rehabilitation to usual care demonstrated a moderate positive effect on functional independence, with the most favorable outcomes observed in younger individuals, those with a first stroke, and those treated within 6 months of onset.[2] Two systematic reviews by Nascimento et al (8 and 9 RCTs, respectively) found that home-based rehabilitation yielded outcomes in motor recovery, upper limb dexterity, walking speed, balance, and daily activities that were equivalent to center-based care.[5,6] Additionally, a separate meta-analysis of 46 RCTs reported superior performance in ADLs among patients receiving home-based services, suggesting that rehabilitation in familiar environments may enhance independence in self-care activities.[3] Moreover, emotional support and counseling provided by nurses, social workers, or other professionals in the home setting can moderately reduce depressive symptoms when compared with usual care.[4] These findings underscore the value of integrating caregiver support and personalized home-based interventions into stroke rehabilitation strategies.
3. During the COVID-19 pandemic, telerehabilitation therapies were widely adopted to provide stroke rehabilitation in the absence of in-person care. Postpandemic, its use has continued value, particularly for patients facing logistical or physical barriers to clinic-based or home health services.[25] The current body of literature evaluating telerehabilitation is characterized by substantial heterogeneity across trials, resulting in evidence of low to moderate quality.[26] Furthermore, the interactive and communication technologies studied include telephone, the internet, VR, and performance monitoring via sensors or wearable devices. Nonetheless, RCTs and systematic reviews generally support the equivalence of telerehabilitation to conventional in-person therapy or usual care for promoting functional recovery among patients with mild to moderate impairments.[7,9,10,26–29] A clinical trial involving individuals with mild to severe

upper limb motor deficits, conducted between 4 and 36 weeks poststroke, demonstrated that telerehabilitation using computer-based gaming was noninferior to in-clinic arm and hand therapy, irrespective of time since injury.[8] Additionally, a comparative study of a telerehabilitation program for upper limb training in chronic stroke patients versus geographic controls receiving minimal therapy reported superior outcomes in the telerehabilitation cohort.[30] Evidence regarding telerehabilitation's impact on balance function is inconsistent and of low quality but generally favors noninferiority to in-person care in a Cochrane review.[11,26,31–33] However, current data are insufficient to support its use as a practical, safe, or effective modality for gait training.

4. Postrehabilitation exercise is essential for persons with stroke, yet conventional fitness centers often lack appropriate accommodations. Community-based adaptive exercise programs have demonstrated clinical benefits with limited-quality evidence. In a nonrandomized trial, an 8-week program for individuals with mild to moderate hemiparesis improved gait endurance, balance, physical performance, and quality of life at 16 weeks, with sustained improvements in ADLs and a reduced need for formal therapy at 12 months. Participants also experienced fewer fractures.[12,15] Additionally, a retrospective cohort analysis of an adaptive cardiac rehabilitation program showed a 4-fold reduction in mortality and improved cardiovascular and physical function at 1 year poststroke.[13] In contrast, community programs focused primarily on education with minimal physical activity did not yield functional improvements over usual care.[14]
5. Hospital- and home-based transitional rehabilitation programs offer measurable clinical benefits for persons with stroke moving from acute care to community settings. However, the necessary level of resource investment remains uncertain. A systematic review of 30 studies found that health coaching, structured telephone follow-up, and home visits postdischarge can improve ADLs, quality of life, and patient self-efficacy.[34] Programs primarily led by nursing staff show mixed outcomes: Duncan et al[18] reported no improvement in Stroke Impact Scale scores, while Wong et al[21] found gains in 36-Item Short Form Survey scores and patient satisfaction. It is notable that transitional teams that include both a physician and coordinator have been associated with better outcomes.[20] Occupational therapist–led programs targeting home independence using goal-directed interventions show variable effects: Bollinger et al.[17] found no impact on the Reintegration to Normal Living Index, whereas Krauss et al[19] reported reduced mortality and a lower rate of nursing home admission. Caregiver-focused transitional programs led by nurses improve health literacy and caregiving ability and reduce caregiver strain.[34–36] Despite these benefits, cost-effectiveness data for hospital-to-home transitional rehabilitation programs remain lacking.

Knowledge gaps and Future Research

- The clinical indications for poststroke telerehabilitation remain to be clearly defined. Current evidence suggests a relative advantage for ADL training via telehealth, whereas gait rehabilitation may be better suited to in-person therapy.[27,33] Moreover, conventional outcome measures used in stroke rehabilitation have not been validated for remote assessment, though instrumented activity monitoring tools may offer a viable alternative.[37] Further investigation is warranted to better understand the factors influencing patient preferences for telerehabilitation, including accessibility, perceived efficacy, and psychosocial determinants.[28]
- Emerging technologies such as VR and robotics have been explored for use in home-based stroke rehabilitation.[38,39] However, comparative data evaluating their efficacy relative to conventional in-person home therapy or therapist-guided telerehabilitation remain limited. Current evidence does not yet clarify whether these modalities offer superior, equivalent, or complementary benefits in functional recovery. Further research is warranted to define the clinical indications, patient selection criteria, and implementation strategies for rehabilitation technologies in the home setting.

7.5. Sexual Function

Recommendation for Sexual Function
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendation
2b	B-NR	1. In persons with stroke, it may be reasonable for health care providers to discuss issues of sexual function.[1–9]

Synopsis

Sexual dysfunction is reported by >50% of persons with stroke[1] and is unrecognized and under-addressed by health care providers for a variety of reasons.[2–4] Health care providers may be unprepared to address sexuality issues with survivors and their partners due to a lack of structured and formal preparation.[2,3,8,9] Despite previous recommendations,[10] there continues to be a need for structured multidisciplinary integration of sexual health in rehabilitation programs.

Recommendation-Specific Supportive Text

1. Sexuality is an important aspect of quality of life for persons with stroke and their partners. Despite the occurrence of sexual dysfunction in both women and men of all ages[5] and the individual variation

of symptoms, survivors report a high incidence of sexual dysfunction following stroke that is not fully addressed or completely goes unrecognized by health care providers.[2–4] Additionally, there is a lack of literature on assessment, treatments, and recommendations for rehabilitation programming.

Multiple studies conclude that persons with stroke and their partners desire more information about sexuality from their health care providers.[6] They have concerns about sexuality but are reluctant to broach the subject due to embarrassment or cultural beliefs.[1,7] Health care providers are reluctant to address these issues for a variety of reasons, including time constraints, cultural beliefs, or lack of knowledge. Additional training, time, and organizational support strongly influence knowledge, comfort, and practices for health care providers.[1,7–9] Reflective practice and models such as the PLISSIT model (permission, limited information, specific suggestions, and intensive therapy) may empower professionals to address these concerns in persons with stroke.[9]

Health care providers should offer patients an opportunity for these conversations and explore the causes of sexual dysfunction regardless of the age of the survivor. These conversations should likely occur at every phase of poststroke care. A thorough assessment should address comorbidities such as diabetes, hypertension, hyperlipidemia, obesity, smoking, psychological aspects (anxiety and depression), medication adverse effects,[11] stroke-related physical and functional deficits, lack of knowledge, safety concerns, role changes, and changes in libido.[1]

Knowledge Gaps and Future Research

- Development of validated, gender-inclusive, holistic assessment tools
- Routine intradisciplinary integration of sexual health into structured stroke rehabilitation programs
- Standardized provider training
- Prioritization of large, rigorous trials that include diverse populations and long-term follow-up
- Attention to female sexual dysfunction and couple-focused interventions

7.6. Recreational, Leisure, and Social Activity Participation

Recommendations for Recreational, Leisure, and Social Activity Participation
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	B-NR	1. In persons with subacute and chronic stroke, an individualized assessment and treatment plan is recommended to address changes in leisure and social participation patterns to improve quality of life, health, and leisure satisfaction.[1–4]

Recommendations for Recreational, Leisure, and Social Activity Participation (Continued)

COR	LOE	Recommendations
1	B-NR	2. In persons with stroke, it is recommended to screen and discuss social health, including social isolation, feelings of loneliness, and limited social supports and networks, to decrease stroke mortality and secondary stroke risk and improve quality of life.[5–9]
2a	B-R	3. In community-dwelling adults poststroke, it can be beneficial to provide individually tailored leisure education and counseling related to meaningful and healthy leisure engagement to improve quality of life; psychological functioning; and leisure satisfaction, engagement, and competence; and to reduce perceived leisure barriers.[10]
Specific Activity-Based Recommendations*†		
1	B-NR	4. In persons with stroke, it is recommended that regular engagement in personally meaningful leisure time physical activity be facilitated through individually tailored education, counseling, caregiver-mediated support, and programming to promote holistic health and reduce poststroke mortality risk.[11–16]
2a	B-R	5. In persons with stroke, incorporation of nature-based activities and green space exposure can be beneficial to reduce stroke disability and mortality risk, and to improve physical, cognitive, social, and psychological functioning; well-being; and quality of life.[17]
2b	B-R	6. In persons with stroke, it may be reasonable to incorporate evidence-based leisure and recreation activities such as tai chi, qigong, commercial exergames, visual arts, yoga, adapted sports, music, immersive commercial video games, Pilates, and dance to support health and recovery.[18–27]

*Although an individual's leisure is highly personalized and contextualized, consider the utilization of the evidence-based activities for those who can tolerate and engage in these activities safely.

†Please see Table 11 for a further description of these activities.

Synopsis

Engagement in personally meaningful leisure is a key determinant for health and quality of life; however, this aspect has not always been systematically integrated or emphasized within health care practice.[3] Prestroke leisure activity is a potential prognostic indicator for executive functioning poststroke, highlighting the importance of prestroke leisure in building cognitive reserve.[28–30] Poststroke, it is common for leisure engagement to become less cognitively active and more sedentary, solitary, and home-based, with decreased engagement in the number, type, and range of activities, leading to negative impacts on mental and physical health,[1–3,31] including loneliness,[5,9] that increases stroke mortality[7] and secondary stroke risk.[8] Each person's leisure interests, abilities, preferences, satisfaction, goals, facilitators, and constraints are unique. This uniqueness requires an individualized assessment and treatment plan to evaluate and address changes in leisure and social participation patterns;[1–4,10,31–42] individually tailored leisure education and counseling;[10] and development of skills, knowledge, and support to engage in a well-rounded, healthy leisure lifestyle.[1–4,10,31–39,41,42] Although leisure is highly personalized and contextualized, the literature indicates that some leisure activities are effective, including LTPA,[11–16,43,44] nature-based activities and green space exposure, tai chi,[18,19,45–50] qigong,[19,47–49] commercial exergames,[26,51,52] visual art–based activities,[25,53–55] yoga,[20,48,49] adaptive sports,[23,56,57] music-based activities, immersive commercial video games, Pilates,[21,49] and dance-based activities. However, the levels of evidence supporting the effectiveness of these activities are variable.

Recommendation-Specific Supportive Text

1. Participating in a variety of mentally and socially stimulating activities throughout life, including leisure activities, builds cognitive reserve that acts as a buffer to lessen cognitive decline poststroke and promote recovery.[28–30] Poststroke, it is common for leisure engagement to become less cognitively active and more sedentary, solitary, and home-based, with decreased engagement in the number, type, and range of activities, leading to negative impacts on mental and physical health.[1–3,31,40] Leisure activity poststroke reduces by between 10% and 40%, with an average activity reduction of 22%.[1] This reduction also becomes more pronounced over time,[4] with more participation restrictions and desire for increased participation in younger adults poststroke.[2] Barriers and facilitators to meaningful leisure and social activity engagement include personal factors (knowledge, habits, beliefs, values, activity goals, functional independence, and psychological, physical, cognitive functions) and environmental factors (adaptive equipment, transportation, services, information, attitudes and behaviors of others, weather, social support, obligations, physical environment, reminders, prescheduled activities).[31,37,38] Motivation and environmental opportunity,[36] higher resilience,[42] positive-thinking coping style,[33] higher perceived living environment satisfaction,[33] fewer perceived ability limitations,[33] and social support were found to predict increased leisure and social participation.[34] Stroke severity,[39] depressive symptoms,[4,35] and higher stroke-related sequelae were found to predict decreased leisure and social participation.[33,35,41] In young persons with stroke, restricted participation in active recreation has been linked to challenges with communication, increased depressive symptoms, reduced mobility, and living alone, with researchers highlighting the importance of implementing sustained interventions and providing comprehensive support to address these diverse needs.[40] Leisure and community participation were also found to be early predictors of later functional motor independence and social support, and that social engagement was a positive predictor of higher life satisfaction, highlighting the fact that while participation is a rehabilitation outcome, it can also be a predictor of other important rehabilitation outcomes.[32] Stroke caregivers also have declined engagement in valued activities, leading to social isolation and poor mental health and wellbeing; however, benefits of, and strategies to enhance, activity maintenance require more research.[58–60]
2. Loneliness and social isolation have been identified by the US Surgeon General as a concerning epidemic.[61] Poststroke individuals commonly experience social isolation,[3,6,61,62] inadequate social networks and support,[8] and feelings of loneliness (Table 9).[5,9] A large secondary analysis of adults poststroke (n=140 953) found high levels of loneliness,[9] with another study (n=244) finding loneliness poststroke occurs in 1 of every 3 individuals.[5] A large systematic review of 19 studies (n=1 675 707) with follow-up periods spanning 4 months to 30 years, found that social isolation, limited social networks, lack of social support, and loneliness were associated with a high risk of poststroke mortality.[7] Other studies found that poor social relationships poststroke were associated with a 32% increase in secondary stroke,[8] and loneliness predicted poorer quality of life.[63] Despite the significance of needing to screen (Table 10) and address loneliness,[5] information about factors associated with loneliness[6,62,64] and interventions for loneliness are lacking.[9,43,44,64] A recent review suggests that improving functional ability, enhancing social skills, providing social support, increasing social opportunities, and addressing maladaptive social cognitions might be helpful, but more research is needed.[43] Another study advocates for the identification of novel clinical solutions such as social prescriptions alongside standard treatment that focus on quality social connections.[5]
3. Leisure education focuses on educating individuals about leisure (leisure awareness), leisure resources, and how to negotiate leisure barriers and strengthen facilitators; whereas leisure counseling focuses on exploring a person's leisure attitudes, feelings, and values to remove obstacles and bolster facilitators to healthy leisure engagement.[10] While leisure education and leisure counseling are commonly a combined approach, the terms are sometimes used interchangeably.[10] Additionally, the literature may refer to only 1 of the methods, despite both being used.[10] A recent systematic review on leisure education and leisure counseling[10] yielded 3 studies – 2 RCTs[65,66] and

Table 9. Definitions of Social Health Factors[61]

Term	Definitions
Loneliness	A subjective distressing experience that results from perceived isolation or inadequate meaningful connections, where inadequate refers to the discrepancy or unmet need between an individual's preferred and actual experience.
Social isolation	Objectively having few social relationships, social roles, group memberships, and infrequent social interaction.
Social networks	The individuals and groups a person is connected to and the interconnections among relationships. These "webs of social connections" provide the structure for various social connection functions to potentially operate.
Social support	The perceived or actual availability of informational, tangible, and emotional resources from others, commonly one's social network.

1 quasiexperimental study[67] with small samples of community-dwelling adults poststroke (total n=86). The 2 RCTs utilized the same 12-step leisure education/leisure counseling program, with participants who had mild cognitive impairment, in their homes and communities for 1 hour per week for 8 to 12 weeks; the quasiexperimental study facilitated a group-based leisure education/leisure counseling couples' program for 5 sessions over the course of 8 weeks (extent of cognitive status not reported). The provision of leisure education/leisure counseling resulted in significantly improved quality of life,[65,66] leisure satisfaction,[65,66] autonomous leisure practice,[65–67] leisure competence,[67] and a reduction in depression[66] and leisure barriers.[67] Outcomes from the provision of leisure education and leisure counseling should be interpreted with caution due to heterogeneous studies with small samples and mixed quality.

4. Regular engagement in physical activity significantly benefits health and recovery poststroke (see section 5.1, "Physical Activity" and section 5.8, "Lifestyle Modification and Management") and reduces all-cause mortality risk.[12,16] While physical activity and home exercise program adherence are notably low poststroke,[68,69] a focus on tailored and personalized LTPA could potentially improve participation.[15]

Table 10. Social Isolation and Loneliness Assessment Tools With Good to Strong Psychometric Properties[43]

Social isolation	Lubben Social Network Scale-6 (LSNS-6), 6 items
	Lubben Social Network Scale (LSNS), 18 items
	Stroke Social Network Scale (SSNS), 19 items
Loneliness	UCLA Loneliness Scale-3 (UCLA-3), 3 items
	Revised UCLA Loneliness Scale (R-UCLA), 20 items
	De Jong-Gierveld Loneliness Scale-6 (DGLS-6), 6 items
	De Jong-Gierveld Loneliness Scale-11 (DGLS-11), 11 items
	Social and Emotional Loneliness Scale for Adults-Short Form (SELSA-S), 15 items
	Differential Loneliness Scale (DLS), 60 items
	Patient-Reported Outcomes Measurement Informational System (PROMIS) – Social Isolation, 8, 6, and 4 item short forms (Note: Although titled "social isolation," it measures subjective experiences of feeling detached and disconnected from others rather than objective measures of social contact or network size)

Qualitative studies show that sustained positive engagement in physical activity is influenced by social connection and support,[11,13,15] self-efficacy,[11,15] a sense of control,[14] and positive physical and psychological experiences.[13,15] This is achieved through LTPA that reflects the person's interests and prestroke identity,[11,14,15] rather than just exercises focused on specific body functions.[11,14] Other factors that support LTPA engagement include strong behavioral beliefs,[13] activity practicality,[15] group intervention programs and exercise games matched to individual abilities and preferences,[13] and LTPA routines, reminders, and activity monitors,[13] along with the use of formal LTPA programs for individuals with low self-efficacy or a sedentary prestroke identity.[11] Research also indicates obstacles to LTPA engagement, including uncomfortable symptoms, environmental constraints, caregiver-related factors, negative psychological experiences, and insufficient understanding of physical activity.[13] By understanding these factors, health professionals can collaborate with persons with stroke to help them resume valued LTPA or develop a strategy for a more active lifestyle.[11]

5. A 2025 systematic review of 38 studies (n=39 084) found that in early stroke recovery, viewing outdoor and natural elements created feelings of serenity and well-being; therapy in outdoor garden spaces improved intentional behaviors; and natural light, sounds, and images reduced depressive mood, anxiety, and fatigue and improved well-being.[17] Regarding specific nature-based activities, forest immersion (also called forest bathing or shinrin-yoku) reduced depression, anxiety, stress, and functional disability; gardening improved psychological, physical, social, and cognitive functions, as well as ADLs and quality of life; surfing improved psychoemotional and physical functions and provided an opportunity to reconnect with valued hobbies and one's identity; and ocean walks improved physical functions and well-being.[17] Proximity to green space was associated with reduced poststroke disability and mortality,[17] which was also supported in another systematic review of 27 studies that included poststroke populations ranging from 374 participants to a population-based

Table 11. Evidence-Based Recreational, Leisure, and Social Activities

Activity	Key outcomes *All findings should be interpreted cautiously.*	Key evidence highlights *Succinct summary*
LTPA: Voluntary physical activity performed during free time for enjoyment or health-related benefits.	Facilitators: social connection and support,[11,13,15] self-efficacy,[11,15] sense of control,[14] positive physical and psychological experiences,[13,15] reflect the person's interests, sense of self, individual character traits, and prestroke identity,[11,13,15] strong behavioral beliefs,[13] activity practicality,[15] group intervention programs and exergames matched to abilities and preferences,[13] LTPA routines, reminders, and activity monitors,[13] formal LTPA programs.[11] Obstacles: Uncomfortable symptoms, environmental constraints, caregiver-related factors, negative psychological experiences, insufficient understanding of physical activity.[13] *See section 5.1, "Physical Activity" and section 5.8, "Lifestyle Modification and Management" for explanation of health and recovery benefits.*	**Evidence**: 3 metasyntheses comprising 38 qualitative studies (n=561) and one primary qualitative study (n=38) in subacute and chronic stroke with specific intervention activities not reported. **Limitations**: Potential omission of relevant studies and publication bias, potential bias associated with patient self-reporting, variability in qualitative research quality, inadequate reporting of researcher-participant relationships, recruitment strategies, and ethical considerations.
Nature-based activities and green space exposure: Involve participation in or interaction with natural elements and environments.	Viewing outdoor and natural elements: Feelings of serenity and well-being[17] Therapy in outdoor garden spaces: Intentional behaviors[17] Natural light, sounds, and images: Depression, anxiety, fatigue, well-being[17] Forest immersion: Depression, anxiety, stress, functional disability[17] Gardening: Psychological, physical, social, and cognitive functions, activities of daily living, quality of life[17] Surfing: Psycho-emotional and physical functions, opportunity to reconnect with valued hobbies and one's identity[17] Ocean walks: Physical functions, well-being[17] Proximity to green space: Poststroke disability and mortality,[17,70] protective association with stroke incidence/prevalence[70]	**Evidence**: 1 systematic review comprising 38 studies, of which 4 were RCTs with all remaining studies mostly qualitative, quasi-experimental, and cross-sectional designs (n=39 084) and 1 systematic review comprising 27 studies with no RCTs, with the majority cross-sectional and cohort studies (sample sizes ranged from 374 participants to a population cohort of 4.3 million) in all stages of stroke recovery. **Limitations**: Interventions and protocols were highly heterogeneous, potential selection bias, limited consideration of the effect of urban versus rural green space, variability in measurement tools, variable methodological quality, subjective nature of individuals' experiences within natural environments.
Tai chi: A mind-body exercise originating in China that combines gentle, flowing, structured, and sequenced movements with deep breathing and meditation. Rooted in martial arts, it emphasizes balance, coordination, and postural control.	Risk of fatal stroke,[48] motor function,[18,46–48] fall risk,[18,49] balance,[47–50] exercise capacity/endurance,[49,50] walking speed,[49] activities of daily living,[18,46,48] depression,[45,47,48,50,71] anxiety,[45] quality of life[48]	**Evidence**: 8 systematic reviews comprising 112 RCTs (n=12 872) in subacute and chronic stroke. **Limitations**: Interventions and protocols were highly heterogeneous, methodological quality ranged from low to high, small sample sizes, potential omission of relevant RCTs, variability in measurement tools.
Qigong: A Chinese mind-body practice that combines gentle, flowing, repetitive, and adaptable movements with deep breathing and meditation. It emphasizes health and wellness and is traditionally intended to cultivate the body's energy, known as *qi*.	Balance,[19,48,49] neurological function,[19] motor function,[47] activities of daily living,[19] depression,[47] quality of life[19,48,49]	**Evidence**: 4 systematic reviews comprising 42 RCTs (n=2073) in subacute and chronic stroke. **Limitations**: Interventions and protocols were highly heterogeneous, methodological quality ranged from low to high, small sample sizes, potential omission of relevant RCTs, variability in measurement tools, challenges related to participant blinding.
Commercial exergames: Video games that use motion-tracking technology to translate players' physical movements into in-game actions, requiring active body movement to interact with the game. Examples include swinging an arm to hit a virtual tennis ball, mirroring dance movements, or performing sport- and exercise-based activities such as walking or boxing.	Balance,[51] upper extremity function,[26,52] lower body motor function,[52] mobility, cardiorespiratory function, musculoskeletal outcomes, physical activity, depression, quality of life[51]	**Evidence**: 1 umbrella review comprising 11 meta-analyses (n=9615), 1 systematic review comprising 50 observational and experimental studies (n=905), and one systematic review comprising 40 studies, of which 13 involved individuals with stroke, including 10 RCTs (n=218) in all stages of stroke recovery, with Nintendo Wii and XBOX Kinect most common platforms. **Limitations**: Interventions and protocols were highly heterogeneous, variability in measurement instruments and study methodologies, small sample sizes, methodological quality ranged from moderate to high or was not assessed.
Visual art-based activities: Involve creating visual works using tangible art and craft materials, such as drawing, painting, clay work, collage, handicrafts, paper crafting, weaving, embroidery, textiles, coloring, and printmaking.	Daily living,[54] upper extremity function,[25,53] fine motor ability, hand coordination, cognitive ability,[25] depression,[25,53] psychological and emotional well-being functions such as anxiety, hopelessness, and negative emotions[25] Qualitative: appreciation of opportunities, self, others, and life,[55] social interaction, enjoyment, distraction from stroke, re-establishment of one's social identity, confidence, self-efficacy, goal attainment, communication, sense of control and hope, self-esteem, mood[54]	**Evidence**: 2 systematic reviews comprising 24 studies, of which 18 were RCTs (n=1345) and 2 were qualitative studies (n=38) in all stages of stroke recovery. **Limitations**: Interventions and protocols were highly heterogeneous, low to moderate methodological quality, small sample sizes.

(*Continued*)

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Table 11. Continued

Activity	Key outcomes *All findings should be interpreted cautiously.*	Key evidence highlights *Succinct summary*
Yoga: An ancient Indian mind-body practice that aims to integrate the body, mind, and spirit through physical postures (*asanas*), breathing techniques, and meditation.	Balance,[49] fear of falling,[49] depression,[20,49] anxiety,[20,49] quality of life[48,49] Qualitative:[72] ROM, stability, ability to perform tasks/actions, emotional regulation, improved community and social participation through the development of greater confidence and friendship development	**Evidence**: 3 systematic reviews comprising 15 RCTs (n=272) and 1 primary qualitative study (n=26) in chronic stroke, with Hatha yoga most common. **Limitations**: Interventions and protocols were heterogeneous, low to moderate methodological quality, small sample sizes, variability in measurement instruments and study methodologies, potential confounding related to medication changes.
Adapted sports: Competitive and recreational sports that are modified in rules, equipment, or structure to facilitate participation by individuals with disabilities.	Sitting boxing:[23] balance, upper extremity motor function, gait speed, quality of life Volleyball:[23] upper extremity limb function and hand dexterity Dance:[23] balance Golf:[23,76] visual spatial memory, visual imagery, mood, balance, coordination, upper extremity strength Horse riding:[23] balance, functional mobility, dynamic balance, fall risk, walking ability, perception of recovery, functional capacity, mental health Kickboxing:[23] balance Standing Boxing:[56] scapular mobility in hemiparetic upper extremities Adaptive cycling:[75] physical, psychological, and social health Mixed adapted sports program:[57] physical activity, quality of life, balance, upper extremity ROM, strength, endurance, mood, socialization, sense of belonging, and well-being.	**Evidence**: 1 systematic review comprised of 30 studies, of which 7 involved individuals with stroke and 5 were RCTs (n=264), in addition to 1 primary RCT (n=60), and 3 primary quasi-experimental studies (n=56) in chronic stroke. **Limitations**: Interventions and protocols were highly heterogeneous, small sample sizes, mixed methodological quality, lack of follow-up assessment, potential bias related to participants' prior experience with adaptive sports, nonblinded evaluators, frequent reliance on self-report measures.
Music-based activities: Include receptive and active components. Receptive activities involve music listening, song discussion, music-assisted relaxation, music appreciation, and song reminiscence, while active activities include playing instruments, movement to music, songwriting, composing, and body percussion (eg, stomping, clapping, snapping).	Executive functioning,[78] emotional well-being,[24,78] gait parameters,[78] balance,[78] upper extremity (strength, ROM, dexterity, function),[77,78] quality of life,[77] mood[78]	**Evidence**: 3 systematic reviews comprising 88 studies, of which 53 were RCTs (n=3282) in all stages of stroke recovery. **Limitations**: Interventions and protocols were highly heterogeneous, small sample sizes, moderate to high risk of bias, substantial variability in methodological quality, potential placebo effect may have been present.
Immersive commercial video games: Involves using a VR headset to immerse the user in a simulated environment featuring interactive visuals, sound, and narrative elements. Interaction may involve upper and/or lower limb movement, facilitated through hand controllers, hand-tracking technology, or other movement-based input systems.	Upper limb motor function[27]	**Evidence**: 1 systematic review comprising 23 RCTs (n=395) in subacute and chronic stroke, using Oculus Rift, Oculus Quest, HTC Vive, and Pico GO VR systems with hand-tracking. **Limitations**: Interventions and protocols were highly heterogeneous, small sample sizes, commercial VR games may lack scientific validation, hand dysfunction may have limited participants' ability to hold controllers and reduced accuracy of upper limb movement tracking, cultural and contextual factors in game design may have reduced patient engagement and influenced outcomes.
Pilates: A low-impact mind-body exercise method that focuses on core strength, muscular endurance, and flexibility through controlled, precise movements. It can be performed on a mat or using spring-assisted apparatus (eg, a reformer).	Static and dynamic balance, quality of life, gait speed, cardiopulmonary function,[21,49] falls[49]	**Evidence:** 2 systematic reviews of RCTs comprising 10 studies (n=213) in subacute and chronic stroke, with most studies including participants able to walk unaided and mat-based Pilates with a high level of individual supervision. **Limitations:** Protocols were generally homogeneous for intervention duration, frequency, and overall length, but heterogeneous regarding the specific Pilates exercises utilized; methodological quality ranged from poor to good; high or unclear risk of bias; small sample sizes.
Dance-based activities: Include a variety of dance styles such as ballet, contemporary, folk, tango, jazz, ballroom, merengue, bolero, and dance video games. Movements may be choreographed or improvisational.	Dynamic balance,[73] gait coordination,[22] functional mobility,[22,73,74] mood,[22] fatigue,[22] lower limb strength,[22] spatiotemporal gait parameters[73]	**Evidence:** 3 systematic reviews, majority quasi-experimental, comprising 21 studies (n=524) in subacute and chronic stroke, with most studies including participants able to walk unaided. **Limitations:** Intervention protocols were highly heterogeneous, methodological quality was mixed, small sample sizes, risk of bias.

LTPA indicates leisure-time physical activity; RCTs, randomized controlled trials; and VR, virtual reality.

cohort of 4.3 million, finding that green space had a protective association with stroke incidence/prevalence, a significantly lower risk of stroke mortality, and a reduced risk of poststroke disability.[70] Despite study variability, researchers suggest that urban and health care designers, health care professionals, and people with stroke incorporate nature wherever possible due to its potential for significant positive outcomes in stroke recovery.[17]

6. In persons with stroke, tai chi,[18,45–50,71] qigong,[19,47–49] yoga,[20,48,49,72] Pilates,[21,49] dance-based activities,[22,73,74] adapted sports,[23,56,57,75,76] music-based activities,[24,77,78] visual arts,[25,53–55] commercial exergames,[26,51,52] and immersive commercial video games[27] can be considered as adjuncts to support rehabilitation and participation outcomes. Collectively, these interventions represent a broad range of experiential, movement-based, recreational, and mind-body approaches that promote engagement in meaningful and often enjoyable activities. Despite variation in theoretical foundations, delivery formats, and dosage, they commonly integrate physical movement with cognitive engagement and psychosocial participation. Across the evidence base, potential benefits are observed in motor function, balance, mobility, and upper and lower limb outcomes, alongside improvements in psychological well-being, mood, confidence, participation, and quality of life. Several approaches also demonstrate benefits related to social connection, identity, and emotional regulation, supporting a holistic approach to stroke recovery. However, the overall evidence is limited by heterogeneity in interventions and outcome measures, variability in methodological quality, and frequent issues including small sample sizes and risk of bias. Although randomized trials and meta-analyses generally report positive effects across multiple domains, the magnitude and durability of these effects remain uncertain. Therefore, findings should be interpreted with caution, and clinical application should be individualized based on patient preferences, capacity, and context. See Table 11 for detailed descriptions of each activity, associated outcomes, supporting evidence, and limitations.

Knowledge Gaps and Future Research

- Research on the efficacy of specific recreation and leisure activities in the poststroke population that did not have sufficient research to be included as recommendations in the 2026 guidelines, including but not limited to, Ai Chi, meditation, mindfulness, journaling, Nordic pole walking, swimming, tablet games, desktop computer games, and nontechnology games (eg, board games, cards, puzzles, brain games, tabletop games).
- Research on the creation, implementation, and outcomes of leisure tune-ups (eg, every 6 months) to enhance social and leisure participation poststroke
- Development of quantitative measures that reflect the meaning of optimal leisure re-engagement as understood by persons with stroke
- Research on leisure and social engagement as short-term and long-term predictors of rehabilitation outcomes, quality of life, health, and recovery trajectory
- Research on the impact of specific types of prestroke leisure activities (eg, physical activity, social activity, cognitively stimulating activity) on cognitive reserve and their association with primary and secondary stroke impairments and recovery
- Research that compares short-term and long-term outcomes of prescribed standardized exercises versus participation in personally meaningful physically active leisure and recreational activities poststroke
- Research on specific treatment ingredients to better prescribe specific recreation, leisure, and social activities poststroke (eg, dosage, treatment structure, frequency, facilitation techniques, setting, environment, equipment, objects, theories, models) with long-term follow-up
- The impact of meaningful leisure engagement and the positive emotions experienced through meaningful leisure engagement on neuroplasticity and longitudinal changes in recovery poststroke
- Research on novel interventions aimed at increasing and sustaining healthy leisure and social participation in chronic stroke, such as social prescribing
- Research on interventions to reduce loneliness and target mediating pathways to loneliness

7.7. Return to Work

Recommendations for Return to Work
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
2a	B-R	1. In persons with stroke, it is reasonable to provide an early, tailored vocational rehabilitation program delivered by occupational therapy and vocational services to promote return to work.[1–5]
2a	B-R	2. In persons with stroke, an assessment of vision, perception, manual dexterity, motor abilities, cognitive ability, and job-specific demand factors can be beneficial to tailor services and promote return to work.[5]
2a	B-R	3. For persons with stroke, modified job duties and work adaptations are reasonable to support return to work.[3–10]
2a	B-R	4. In individuals living with stroke, fatigue management, cognitive and psychosocial support, and early employer engagement in vocational rehabilitation are reasonable for promoting return to work.[3–5,7–14]

Synopsis

With the improvement of acute stroke management, stroke burden has increased since 1991. This is partially due to the increased incidence of stroke in individuals aged 15 to 49 years in the Southern and Midwestern United States.[15,16] In addition, the older adult population (≥65 years) in the United States is expected to double in the next 40 years.[15,17] Thus, as stroke incidence increases with age, a growing number of older Americans will be living with poststroke disabilities.[18] Moreover, income tends to decline poststroke.[3,10,19] A cohort study found that median income dropped by 29.6% poststroke, with larger relative losses in lower-income survivors.[19] Persons with stroke are less likely over 3 years to report earning prestroke levels of employment income.[10,19,20] The cumulative effect of reduced income may result in heightened levels of functional dependency, increased demand for services, and a significant economic burden on the health care system.[21] Evidence indicates that graded return to work and work trials, work adaptations, and job re-placements can facilitate return to work after stroke.[3–5,7,8,14] Thus, there is an urgent need for social and vocational support to mitigate financial loss.[19]

Recommendation-Specific Supportive Text

1. Research examining return to work programs poststroke has increased.[1,3–5,9–11,13,22] Evidence indicates that graded vocational programs can increase the success of return to work after a stroke.[4,5] In the RETAKE trial,[4] an early and tailored vocational intervention was delivered by occupational therapists, namely Early Stroke Specialist Vocational Rehabilitation (ESSVR). Using a case-coordination model, the occupational therapists incorporated participants' abilities and preferences, and the job requirements into the intervention. Education regarding stroke impact was provided to the employers. ESSVR was compared with usual care, and the latter was available for both groups. Although there was no difference between groups, a prespecified subgroup analysis indicated that ESSVR was more efficacious for older individuals and that ESSVR had a greater benefit on individuals with 1 or more poststroke deficits.[1,4,9] Another study investigated early return to work, enrolling participants early after stroke. Those randomized to the experimental group received a tailored return to work program provided in the workplace. The comparator group had standard of care intervention in the clinic where previous job demands were considered. However, there was no intervention in the workplace. At 6 months poststroke, 60% of persons with stroke in the experimental group were employed, whereas only 20% of the comparator group had a similar outcome.[5]
2. Despite the importance of returning to work, there is a lack of research documenting the use of appropriate poststroke vocational assessments. In the return to work study reported by Ntsiea and colleagues, participants from the experimental group were administered the Therapist Portable Assessment Laboratory (T/PAL),[23] an instrument that included work modules to identify potential problems including visual discrimination, eye-hand coordination, form and spatial perception, manual dexterity, color discrimination, and cognitive abilities. Also, the test identified vocationally relevant skills, interests, and learning preferences. Although the assessment tool is not specific to persons with stroke, it is a comprehensive instrument incorporating evaluation of cognitive and perceptual skills. Communication between employers and the health care team also occurred, allowing the therapist to incorporate information about the workplace into the plan.[5] La Torre and colleagues recommend more research into which specific cognitive deficits interfere with return to work.[13] In a qualitative study of individuals in various phases of return to work after stroke, participants identified cognitive challenges including cognitive fatigue, cognitive/executive processing difficulties, and reduced motivation. Psychological challenges include fear, anxiety, and lack of psychological/peer support.[24] More frequent use of screening tools and appropriate assessments may improve the quality of vocational intervention.
3. The majority of participants in return to work trials had modifications either in their environment, time spent working, or in their job duties.[5,13] Other studies indicate that work adaptations, psychosocial support, and the individual's changed priorities facilitate both return to work and job sustainability.[14] A meta-synthesis found that factors influencing success in return to work in individuals poststroke include the ability to adapt, intrinsic motivation to work, the availability of vocational services, and job demands that met the individual's present abilities.[7] In the SCORE study (Stroke Cohort Outcomes of Rehabilitation), the authors found that a significant number of participants reported adjustments in employment duties, with several individuals changing jobs.[10] Other alterations of job duties consisted of changes in tasks and activities, modification of working hours (either the amount or the distribution), or use of adaptive equipment. The occurrence of work adaptations decreased with time. Several studies indicate that both help from the employer,

education of the employer about stroke conditions, and reducing work hours were the most essential factors for successful return to work.[10,14]

4. Poststroke fatigue, mood disorders, and cognitive disabilities are negative predictors for return to work poststroke.[13] Other negative predictors include inadequate rehabilitation, longer hospital stays, socioeconomic disadvantages, and manual labor roles. Positive predictors include family support, access to vocational services, a flexible and supportive work environment, white-collar employment, and independence in ADLs.[14,19,22,25,26] An umbrella review found that the main physical disability that negatively influences return to work after stroke is poststroke fatigue. Although fatigue and mood are recognized as negative factors, a systematic review evaluating these issues found that poststroke vocational intervention programs seldom adequately address either mood or fatigue.[11] Moreover, the use of fatigue screening tools is very limited.[11] Some studies suggest that fatigue, mood, and cognitive difficulties may be modified for successful return to work.[1,3–5,9,11,13,14,27] Poststroke fatigue can be treated with both pharmacological and nonpharmacological interventions. Nonpharmacological interventions include CBT techniques, mindfulness, patient education, and aerobic exercise.[28] Lastly, employer engagement is modifiable, and evidence indicates that it contributes to the success of vocational intervention.[4,9,14,25]

Knowledge Gaps and Future Research

- There are few examples of improving cognitive disabilities in the return-to-work poststroke literature. Working memory treatment has demonstrated improvement in specific cognitive domains. However, these improvements did not enhance IADL performance for individuals living with stroke.[29]
- Strategy training has improved ADL performance and community participation.[30] Future studies could investigate whether strategy training may also improve return to work.

7.8. Return to Driving

Recommendations for Return to Driving
Referenced studies that support recommendations are summarized in the online data supplement.

COR	LOE	Recommendations
1	C-LD	1. For persons with stroke who have impairments that could impact safe driving (such as cognitive, perceptual, or physical impairments), referral for an on-road test administered by an authorized person is recommended to determine fitness to drive.[1–4]

Recommendations for Return to Driving (Continued)

COR	LOE	Recommendations
2a	B-NR	2. For persons with stroke, comprehensive assessment of vision, perception, motor ability, and cognition by a trained clinician is reasonable to inform fitness to drive according to safety and local regulations.[1–4]
2a	C-LD	3. For persons with stroke who do not pass an on-road driving test or have impairments that could impact safe driving, driving rehabilitation with an authorized person is reasonable to improve driving capability.[2,5–7]
2b	B-NR	4. For persons with stroke, use of a driving simulator may be considered to estimate driving risks or predict on-road performance.[1,7–10]

Synopsis

Driving is an essential IADL for many individuals. Access to transportation facilitates independence, participation in activities, engagement in social and community life, and access to necessary resources[11]; however, driving is a complex task that relies on the integration of cognitive, perceptual, visual, emotional, and motor skills, all of which can be affected by stroke.[5] Legislative guidance for returning to driving after stroke varies by state. For example, some states require persons with stroke to report their health condition to the appropriate agency, while other states may require providers to report certain medical conditions. Clinicians should be aware of local guidelines and regulatory requirements and ensure that patients are appropriately informed about driving standards. Clinicians are often asked to assess fitness-to-drive after stroke and must evaluate each case individually to make recommendations about driving based on the presence of stroke-related impairments that can impact safe driving.

Recommendation-Specific Supportive Text

1. An on-road test remains the recognized gold standard for determining fitness-to-drive. On-road performance is often used as a primary outcome measure in research evaluating fitness-to-drive screening and assessment.[1,2,4] A formal on-road driving evaluation is performed by a driving rehabilitation specialist or certified driving instructor. A qualitative interview study of stroke providers and occupational therapists suggests that not all patients with stroke will need an on-road test and proposes using a risk stratification model to determine the need for more formalized assessment or rehabilitation based on the severity of stroke-related impairments that can impact safe driving.[3] Some patients with severe impairments will be unable to safely undergo driving evaluation. On the other hand, some patients may be

suitable to return to driving without formalized on-road evaluation. Current evidence does not clearly identify which, if any, neuropsychological tests, screening methods, or batteries precisely classify patients who need formal on-road evaluation for driving.

2. Comprehensive assessment of skills relevant to driving is critical to identify those who legally qualify to drive yet exhibit residual stroke-related impairments that could potentially compromise driving safely and necessitate referral for more specialized assessment or rehabilitation. There is no clear consensus on the use of neuropsychological tests and other screening measures or batteries to adequately predict the ability to drive after a stroke. There is also a lack of consensus on which driving outcomes should be used. Three recent systematic reviews examined the ability of various screening tests to predict driving performance or return to driving across 65 studies (15 overlapping studies).[1,2,4] Most of the primary studies were non-randomized and were conducted in different countries, which limits generalizability due to differing driving conditions. Generally, poor performance on screening tests is associated with reduced fitness to drive outcomes (both in on-road and simulator environments); however, there is high variability and inconsistency across studies. In 2 systematic reviews, performance on the Stroke Drivers Screening Assessment and Trails-Making Test B demonstrated consistently positive associations with on-road or simulator driving test performance.[1,4] Qualitative research emphasizes a combination of standardized assessments, with observation of functional performance to clinically stratify driving risk and inform interventions.[3]
3. Evidence supporting rehabilitation techniques for appropriate patients to improve on-road driving skills after stroke is limited. A Cochrane review of 4 trials found no significant improvement in passing an on-road driving test following rehabilitation interventions.[5] One RCT showed that individualized driving simulator training did not improve overall on-road driving test outcomes compared with controls; however, a subgroup with moderate impairments did have a significantly higher pass rate after the intervention.[7] Another systematic review identified 2 RCTs evaluating the effects of simulator training on neuropsychological tests, only 1 of which showed short-term improvement in outcomes, which were not sustained at 5 years.[2] A separate systematic review found high-quality evidence in 3 of 16 included studies to support the effectiveness of off-road skill-specific training and computer-based driving simulator training.[6] While car adaptations or modifications can be implemented by occupational therapists in driving rehabilitation settings, their effectiveness remains unproven.[6]
4. Driving simulators can be incorporated into the evaluation of fitness to drive by identifying potentially risky behaviors or predicting on-road test performance. However, evidence of their effectiveness is mixed. Two comparative studies found that poststroke drivers performed worse than healthy controls in driving simulator metrics, such as speed and lane position, but the difference was not statistically significant despite poorer cognitive scores in the stroke group.[8,9] In a systematic review, 2 of 3 included primary studies reporting driving simulator assessment did find a significant difference in stroke patients.[1] Furthermore, driving simulator metrics for stroke patients correlated with their neuropsychological test performance and could accurately classify patients' likelihood of passing an on-road test based on a fitness-to-drive probability calculation in an observational study.[10] In another RCT, simulator training did not improve on-road test pass rates compared with controls, though after a subgroup analysis, patients with moderate impairments were more likely to pass the on-road test after the intervention.[7]

Knowledge Gaps and Future Research

- Studies evaluating the utility of neuropsychological tests, screening measures, and assessment batteries are heterogeneous in both study methods and outcome measures. There is a need for more rigorous study designs to better investigate the correlation between neuropsychological tests, screening measures, and assessment batteries with on-road performance, and to facilitate comparison across studies.
- Demographic subgroups of persons with stroke, including women, those younger than 55 years, and those from low-income countries, are underrepresented in fitness-to-drive studies.
- The usefulness of driving simulators in predicting fitness-to-drive and in driver rehabilitation training is not well established.
- There is limited high-quality evidence describing the effectiveness of rehabilitation interventions in improving driving ability or facilitating returning to driving for patients with stroke.

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ARTICLE INFORMATION

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Disclosures

Appendix 1. Guideline Writing Group Relationships With Industry and Other Entities (Relevant)

Writing group member	Employment	Research grant	Other research support	Speakers' bureau/ honoraria	Expert witness	Ownership interest	Consultant/advisory board	Other
Category A- Chair								
Lorie Richards, Chair	University of Utah	None	None	None	None	None	None	None
Nneka Ifejika, Vice Chair	Ochsner Health UT Southwestern Medical Center	None	None	None	None	None	None	None
Joel Stein, Vice Chair	Columbia University Weill Cornell Medicine NewYork-Presbyterian Hospital	BrainQ Technologies* Mobia Medical†	None	None	None	None	Dessintey* BrainQ Technologies* Takeda Development Center Americas, Inc.	None
Mona N. Bahouth, SOC Liaison	Johns Hopkins Medicine	None	None	None	None	None	None	None
Category B (WG Members Who Have No Conflicts)								
Martha Abshire Saylor	Johns Hopkins University	None	None	None	None	None	None	None
A.M. Barrett	UMass Chan Medical School	None	None	None	None	None	None	None
Peii (Peggy) Chen	Kessler Foundation	None	None	None	None	None	None	None
Anne Deutsch	Northwestern University Shirley Ryan AbilityLab RTI International	None	None	None	None	None	None	None
Charles Ellis	University of Florida	None	None	None	None	None	None	None
Janice Eng	The University of British Columbia	None	None	None	None	None	None	None

(*Continued*)

Appendix 1. Continued

Writing group member	Employment	Research grant	Other research support	Speakers' bureau/ honoraria	Expert witness	Ownership interest	Consultant/advisory board	Other
Jamie L. Fleet	Western University St. Joseph's Health Care London	None	None	None	None	None	None	None
Emily S. Grattan	University of Pittsburgh	None	None	None	None	None	None	None
Corinne A. Jones	University of Texas at Austin	None	None	None	None	None	None	None
Chandramouli Krishnan	University of Michigan	None	None	None	None	None	None	None
Sara Kutzle	N/A	None	None	None	None	None	None	None
Deven Matthews	Nevada System of Higher Education	None	None	None	None	None	None	None
Nicole Mazwi	University of Washington	None	None	None	None	None	None	None
Jamila Minga	Duke University	None	None	None	None	None	None	None
Dawn Nilsen	Columbia University	None	None	None	None	None	None	None
Elisabeth Noser	McGovern Medical School	None	None	None	None	None	None	None
Heather Porter	Temple University	None	None	None	None	None	None	None
Dorian K. Rose	University of Florida Malcolm Randall VAMC Brooks Rehabilitation	None	None	None	None	None	None	None
Elizabeth Skidmore	University of Pittsburgh	None	None	None	None	None	None	None
Marie-Pierre St-Onge	Columbia University	None	None	None	None	None	None	None
Mary Stoykov	Shirley Ryan AbilityLab	None	None	None	None	None	None	None
Amelia Tenberg Schettini	Johns Hopkins University	None	None	None	None	None	None	None
Alexandra Terrill	University of Utah	None	None	None	None	None	None	None
David Tirschwell	University of Washington	None	None	None	None	None	None	None
Paul Vilar	Advocate Health	None	None	None	None	None	None	None
Alicen Whitaker-Hilbig	Medical College of Wis-consin	None	None	None	None	None	None	None
Category C (WG Members Who Have Conflicts)								
Wendy Dusenbury	Dusenbury Healthcare, LLC University of Arizona Banner University Medical Center	Ceribell, Inc† Phagen-esis†	None	None	None	None	None	None
Richard Harvey	Shirley Ryan AbilityLab	None	None	Mobia Medical, Inc*	None	None	None	None
Preeti Raghavan	Johns Hopkins Medicine	None	None	Med-Rhythms, Inc.*	None	Mirrored Motion Works, Inc.* Movease, Inc.*	None	
Richard Zorowitz	MedStar Health	None	None	None	None	None	Ipsen Pharmaceuti-cals†	None

This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives $5 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $5 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest (<$5,000)

†Significant (≥$5,000)

Appendix 2. Peer Review Committee Relationships With Industry and Other Entities (Relevant)

Peer review committee member	Employment	Research grant/other research support	Speakers' bureau/ honoraria	Expert witness	Ownership interest	Consultant/ advisory board	Other
Category A (Chair)							
Warren D. Lo, Chair	Nationwide Children's Hospital Ohio State University	None	None	None	None	None	None
George F. Wittenberg, Vice Chair	VA Pittsburgh Healthcare System University of Pittsburgh	None	None	None	None	None	None
Allison E. Gaffey, SOC Liaison	VA Connecticut Healthcare System Yale School of Medicine	None	None	None	None	None	None
Category B (PRC Members Who Have No Conflicts)							
Dipika Aggarwal	University of Kansas	None	None	None	None	None	None
Maria Cecilia Alpasan	Cedars-Sinai Medical Center	None	None	None	None	None	None
E. Jackson Amburn	Centre for Neuro Skills	None	None	None	None	None	None
Sarah K. Ashcroft	University of New South Wales	None	None	None	None	None	None
Oluwole O. Awosika	University of Cincinnati/UC Health	None	None	None	None	None	None
Tamilyn Bakas	University of Cincinnati	None	None	None	None	None	None
Mark Bowden	Brooks Rehabilitation	None	None	None	None	None	None
Robynne Braun	University of Maryland	None	None	None	None	None	None
Julia Carpenter	Shirley Ryan AbilityLab	None	None	None	None	None	None
Paula de la Peña	Loyola University Chicago	None	None	None	None	None	None
Margaret A. French	University of Utah	None	None	None	None	None	None
Mark P. Goldberg	UT Health San Antonio	None	None	None	None	None	None
Marlis Gonzalez-Fernandez	Johns Hopkins Medicine	None	None	None	None	None	None
Jocelyn E. Harris	McMaster University	None	None	None	None	None	None
Abhishek Jaywant	Weill Cornell Medicine	None	None	None	None	None	None
Gert Kwakkel	Amsterdam UMC	None	None	None	None	None	None
Laura M. McPherson	Washington University	None	None	None	None	None	None
Emilia Michou	University of Patras	None	None	None	None	None	None
Ela B. Plow	Cleveland Clinic Rehabilitation Hospitals	None	None	None	None	None	None
Robin White Chism	Patient Representative	None	None	None	None	None	None
Lauren Winterbottom	Columbia University	None	None	None	None	None	None
Stephanie Zawada	Mayo Clinic	None	None	None	None	None	None
Elizabeth Zink	Johns Hopkins Medicine	None	None	None	None	None	None
Category C (PRC Members Who Have Conflicts)							
John Chae	Case Western Reserve University	None	None	None	SPR Therapeutics†	SPR Therapeutics*	Named inventor on issued patents held by SPR Therapeutics* Named inventor on issued patent held by Case Western Reserve University and licensed to Synapse Biomedical (no income)*
Wuwei Feng	Duke University	None	None	None	None	Burke Foundation*	None
Catherine E. Lang	Washington University	None	None	None	None	Medtronic, Inc.*	None
David J. Lin	Massachusetts General Hospital	None	None	None	None	iota Biosciences† Neurotrauma Sciences†	None

(*Continued*)

Appendix 2. Continued

Peer review committee member	Employment	Research grant/other research support	Speakers' bureau/ honoraria	Expert witness	Ownership interest	Consultant/ advisory board	Other
Barbara Lutz	University of North Carolina Wilmington	None	Med-bridge*	None	PATH-2Caregiving, LLC*	None	Intellectual property (copyright and trademark) held by PATH2Caregiving, LLC
Vu Q.C. Nguyen	University of Alabama at Birmingham	Merz Pharma*	None	None	None	None	None
DaiWai Olson	UT Southwestern Medical Center	NeurOptics*	None	None	None	None	None

This table represents the relationships of peer review committee members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the peer review committee are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives $5,000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity or owns $5,000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest (<$5000)

†Significant (≥$5000)

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3. Prevention and Medical Management of Comorbidities

3.1. Prevention of Skin Breakdown and Contractures

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3.9. Sleep and Poststroke Fatigue

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5.7. Adaptive Equipment, Durable Medical Devices, Orthotics, and Wheelchairs

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6. Cognition and Communication

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6.3. Motor Speech Disorders: Dysarthria and Apraxia of Speech

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7. Transitions in Care and Community Rehabilitation

7.1. Ensuring Medical and Rehabilitation Continuity Through the Rehabilitation Process and Into the Community

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7.7. Return to Work

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7.8. Return to Driving

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