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Review

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A scoping review to explore tools used for acute stroke rehabilitation assessment in the G20 countries

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Abstract

Objectives: In this scoping review, we explore whether there is commonality in the tools used for acute stroke rehabilitation assessment in the G20 countries and whether there is a delay in the use of these assessment tools following the onset of symptoms in acute stroke patients.

Materials and methods: Seven electronic databases including PubMed, MEDLINE, CINAHL, EMBASE, Cochrane Library, ScienceDirect, and PEDro were searched from 2014 onwards, supplemented by hand searching. Three reviewers independently screened titles and abstracts and full texts and extracted data using Covidence. Findings were synthesized narratively, with exploratory comparisons across World Bank income groups and World Health Organization (WHO) regions.

Results: Of 11,478 records identified, 911 underwent full-text review, and 26 studies which met the inclusion criteria were analyzed. The most frequently used tools were the National Institutes of Health Stroke Scale (NIHSS), Fugl-Meyer Assessment of Motor Recovery (FMA), and Barthel Index (BI). Median time to first assessment after stroke onset or admission was 3 (interquartile range [IQR], 2 to 10) days. No statistically significant differences were identified across income groups or WHO region; the European Region had the earliest median assessment time.

Conclusion: The NIHSS, FMA, and BI were the most used acute stroke rehabilitation assessment tools in G20 countries, while assessment tools and timing varied across the studies. Strengthening early rehabilitation pathways and standardizing assessment timing and reporting may improve consistency. Representative multinational research is needed to clarify whether observed variation reflects health-system characteristics, clinical practice, resource availability, or methodological differences and to inform future rehabilitation assessment policies and practice.

Keywords: Acute stroke, G20 countries, hemorrhagic stroke, ischemic stroke, stroke assessment tool, stroke rehabilitation assessment.

Stroke is the third leading cause of disability and the second leading cause of death where ischemic stroke alone accounts for 85% of all cerebrovascular diseases and remains the leading cause of death and disabilities globally.[1,2] Evidence suggests that stroke incidence in individuals of working age is on the rise.[3] In 2012, it was revealed by global burden of disease (GBD) findings that stroke should no longer be regarded as a disease of the elderly, as two thirds of all strokes occur among persons less than 70 years of age.[4,5] Evidence from

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different international settings indicate that 20 to 30% of strokes occur in people less than or equal to 65 years in Australia, New Zealand, and the United Kingdom (UK).[6]

Stroke manifests in phases, the acute phase lasts for two weeks after the lesions, the sub-acute phase lasts up to six months after the onset.[7] For this scoping review, reviewers used the definition of acute stroke based on clinical stages, where acute stroke is defined as the onset of stroke symptoms in the first two weeks.[8]

Acute stroke service priorities vary across different healthcare settings according to governments' health structure, geography and culture.[9] In Europe (a member of G20 community), acute stroke remains as one of the leading causes of death and disability, and the projection shows that the burden of stroke is more likely not to decrease in the next decade.[10]

In 2017, there was an estimate of 1.12 million cases of incidence of stroke, prevalence is 9.53 million, 0.46 million stroke deaths, and 7.06 million Disability-Adjusted Life Years (DALYs) lost in the European Union.[2] Europe is a forum comprised of countries with some of the world's largest economies representing all inhabited continents of the world with a focus on global health.[11]

The health gap between the economically advantaged countries of West Europe and the rapidly developing Central and East Europe regions still exists.[12] This may contribute to the expectation of a demographic trend change to 469.5 million citizens in Europe by 2025.[3] and vascular risk factors indicate that a significant increase in the burden of cerebrovascular diseases in the future is likely to occur whereby, 1.5 million European citizens are expected to experience a stroke event in a year by 2025.[13,14]

Stroke rehabilitation is a progressive, dynamic, goal-orientated process aimed at enabling a person with impairment to reach their optimal physical, cognitive, emotional, communicative, social and/or functional activity level.[15] The application of stroke rehabilitation begins shortly after diagnosis with an initial assessment, during which healthcare professionals aim to identify the patient's functional and cognitive impairments. Stroke rehabilitation can be offered in a range of settings, including acute and post-acute care, inpatient rehabilitation units, outpatient and ambulatory care clinics, community clinics, recreation centers, early supported discharge services, and outreach teams.[15] The stroke unit provides care at the basic level, including the early treatment of complications.[16] Patients continue treatment and rehabilitation at rehabilitation stroke unit for several weeks, if necessary.[17]

There is a difference between stroke rehabilitation and stroke care. Stroke rehabilitation is a goal-oriented process which attempts to obtain maximum function in patients who have previous strokes and who suffer from a combination of physical, cognitive and language disabilities,[18] whereas acute stroke care is restoring function that includes medical care. The rehabilitation of acute stroke patients includes the use of acute stroke assessment tools (Table 1).

The World Stroke Organization (WSO) Global Stroke Services Guidelines and Action Plan are intended for all providers for a variety of settings for an organized stroke care.[19] This toolkit strongly recommends that each patient with acute stroke should have an initial functional assessment to determine rehabilitation needs and receive a rehabilitation plan.[19] The same guidelines emphasize that although there are differences in resource availability among countries, it should always be feasible to increase stroke awareness, education, prevention, and treatment.[20] The WSO checklist recommends initiating initial screening within 48 h of hospital admission, followed by additional assessment of impairments, activity limitations, and participation restrictions depending on the clinical condition of the patient.[19]

There is evidence of a decline in disability and mortality as a result of well-established stroke units and the adherence to European Stroke Guidelines which specifies medical treatment beginning within 4.5 h of being admitted to hospital[17] and being seen by rehabilitation professionals within 48 h of admission by rehabilitation professionals as reported by Canadian stroke best practice guidelines.[21] Evidence shows that morbidity and mortality rates from acute stroke are lower

Table 1. Acute stroke assessment tools used in stroke rehabilitation

No.	Name of the tool	Abbreviation	Description
1	Barthel Index	BI	Enables progress to be documented in self-care and mobility skills during[26]
2	Berg Balance Scale	BBS	A clinical outcome measure originally designed to assess the balance of individuals with conditions prone to balance disturbances such as stroke[27]
3	Chedoke Arm and Hand Activity Inventory	CAHAI	An activity-based assessment developed to include relevant functional tasks and to be sensitive to clinically important changes in upper limb function[28]
4	Dynamic Gait Index	DGI	An activity level outcome measure that has shown strong psychometric properties for balance and gait in a non-ataxic population, including stroke patients[29]
5	Fugl-Meyer Assess-ment of Motor Recovery after Stroke	FMA	One of the most comprehensive quantitative measures of motor impairment following stroke and has been recommended for clinical trials of stroke rehabilitation[30]
6	Modified Rankin Scale	mRS	It covers the entire range of functional outcomes from no symptoms to death. Its categories are intuitive and easily grasped by both healthcare providers and patients, its concurrent validity is demonstrated by strong correlation with measures of stroke pathology[31]
7	National Institute of Health Stroke Scale	NIHSS	A major stroke impairment scale, which was first designed as a 15-item neurologic examination scale for use in acute therapy trials.[32] It can be used for both stroke rehabilitation and stroke care. NIHSS helps in providing prevention strategies and patient categorization in designing medical and rehabilitation plans[33]
8	Rivermead Mobility Index	RMI	Used in clinical settings of physical therapy to assess the gait and mobility of stroke patients using standardized assessments such as walking velocity[34]

NIHSS, National Institute of Health Stroke Scale.

in high-income countries (HICs) compared to low and middle-income countries (LMICs).[22] This is likely due to the implementation of evidence-based guidelines in the HIC in routine health practice for primary prevention and management of stroke.[23]

Models for stroke services delivery vary considerably between regions and greatly depend on the system organization, workforce capacity, geographical accessibility, and available resources.[19] The G20 countries were considered for this review process, since they include diverse economies and healthcare systems and have engaged in international efforts to prevent and control non-communicable diseases, stroke.[24] The G20 comprises 19 countries and the European Union, as the same group of countries count around 80% of the world's economic output.[25] This composition provides a useful framework for comparing stroke rehabilitation assessment practices across countries with different levels of economic development and health-system capacity.

Although international guidelines, namely the WSO Global Stroke Services Guidelines and Action Plan recommend early functional assessment and individualized rehabilitation planning, it remains unclear whether countries across the G20 use comparable assessment tools for acute stroke rehabilitation, and whether this assessment is conducted within timeframe following stroke onset. In the present study, we, therefore, aimed to explore whether there was commonality in the tools used for acute stroke rehabilitation assessment in the G20 countries and whether there was a delay in the use of these assessment tools following the onset of symptoms in acute stroke patients.

MATERIALS AND METHODS

Identifying relevant studies

This scoping review was conducted in accordance with the Joanna Briggs Institute methodological guidance[35] and Preferred Items for Systematic Review and Meta-analysis Recommendations (PRISMA)[36] with a focus on evidence pertaining to assessment tools used for the rehabilitation of acute stroke patients.

The search was restricted to studies published from 2014. The rationale for restricting the search to studies published from 2014 onward was that this year marked the publication of the WSO Global Stroke Services Guidelines and Action Plan,[19] which introduced a global framework

for stroke service organization and structured assessment. This cut-off was chosen to focus on the post-guideline era and to examine the use of acute stroke rehabilitation assessment tools in G20 countries within a more contemporary practice context.

Inclusion and exclusion criteria

Population: This scoping review included all published full-text articles reporting on adults over the age of 18 years with either acute ischemic or hemorrhagic stroke who were assessed within 14 days of stroke onset. Studies reporting on subacute stroke or chronic stroke rehabilitation were excluded.

Concept: Studies which reported on rehabilitation assessment tools used in the acute stroke rehabilitation context were eligible. Radiological diagnostic tools, including computed tomography (CT) and magnetic resonance imaging (MRI), were excluded, as the review focused on rehabilitation assessment rather than diagnostic imaging. Systematic reviews, trials focusing on endovascular intervention, Fluoxetine Or Control Under Supervision (FOCUS), FLuoxetine for Motor Recovery After Acute Ischaemic Stroke (FLAME), and other studies which involve medical interventions were excluded. Case series, case reports, editorials, comments, letters, protocols, opinion pieces, and conference proceedings were also excluded.

Context: The review included studies reporting on rehabilitation assessment tools in any of the G20 countries. Evidence from countries outside the G20 was excluded, as the G20 brings together major economies to address shared global challenges, including health and well-being and non-communicable diseases.[37]

Language: Articles published in either English or French were eligible for inclusion. Articles published in other languages were excluded, given that approximately 98% of scientific publications are written in English, including research originating from countries where English is not the primary language.[38]

Data source and search strategy

The data search included the use of seven international databases, namely PEDro, ScienceDirect, PubMed, CINAHL, MEDLINE, Cochrane Library, and EMBASE. Preliminary searches were carried out to examine variation in phraseology in relation to the key search terms that were developed based on MeSH results. The terms were combined with the Boolean operators 'OR,' 'NOT,' and 'AND.' The key words and/or MeSH terms are as follows: *Acute Stroke OR Cerebrovascular Accident OR CVA AND Assess* OR evaluat* OR tool* AND Rehabilitat**.

These terms were established based on the Participants, Intervention, Comparison, and Outcome (PICO) framework.[39] The PICO components were defined as follows: Population: Patients with acute stroke during the first two weeks of rehabilitation; Intervention: Assessment measures used during the first two weeks of stroke rehabilitation; Comparison: Recommendations provided in the WSO Global Stroke Services Guidelines and Action Plan (2014).[19]

Other sources

The reference list of articles for review was manually downloaded and evaluated to reveal whether there were any additional studies that might have been missed out by electronic search.

Data screening and selection

One of the reviewers (NR) in the team imported a comma-separated value (CSV) file from databases to EndNote software for reference arrangements and removal of duplicates. Two reviewers (NR and MCS) independently screened the titles and abstracts imported from EndNote software against the eligibility criteria. Both reviewers used the Covidence software platform, an online web-based software to streamline the scoping review process. In case of conflicts during this screening process, the final decision was reached by a third reviewer (AS). A full text review was undertaken by two reviewers (NR and CC). Any conflicts were resolved by a third reviewer (RR).

Data extraction and management

The purpose of the scoping review was to map the assessment tools used for assessing stroke patients during the acute phase of their rehabilitation. Data extraction was designed by two reviewers who piloted the process. The data was extracted from full-text articles using Covidence online software. Data such as the

author's name, year of publication, aim of study, country in which the study was conducted, study design, population description, type of stroke, assessment tool studied, assessment tool category, and time of assessment following stroke onset/admission were collected. The extraction forms were exported as CSV files for further analysis. The CSV file was copied to an Excel spreadsheet by (NR) and checked by a second reviewer (CC) to check for accuracy.

The identified countries were classified according to the World Bank income classification into HIC, upper middle income (UMIC), and LMIC groups.[40] Countries were also assigned to World Health Organization (WHO) regions (Region of the Americas, South East Asia Region, European Region, Eastern Mediterranean Region, Western Pacific Region) based on the WHO country grouping.

Statistical analysis

The studies included were summarized descriptively by country, World Bank income group, and WHO region as shown in Table 2. Statistical analysis was performed using the SPSS version 29.0 software (IBM Corp., Armonk, NY, USA). For assessment tools, we reported the frequency and proportion of studies using each tool overall and by country/group. For assessment time, we first described the distribution using medians and interquartile ranges (IQRs), as the data were right-skewed. As the unit of analysis was the study and sample sizes per group were modest, we used non-parametric methods for group comparisons and were tested using the Mann-Whitney U test (two-sided). The Kruskal-Wallis test was used to assess the overall differences in assessment time across World Bank income groups and WHO regions. A p value of <0.05 was considered statistically significant.

Table 2. The assessment time of identified G20 countries and their categories

Level	Group/country	Number of studies	Median time (days)	IQR (Q1-Q3)	Min-Max
Country					
	Australia	2	1.5	1.25-1.75	1-2
	Belgium	1	2.0	2.0-2.0	2-2
	China	7	3.0	2.0-5.0	2-7
	Denmark	1	2.0	2.0-2.0	2-2
	Germany	1	1.0	1.0-1.0	1-1
	India	2	4.0	2.5-5.5	1-7
	Japan	5	10.0	10.0-14.0	1-14
	Russia	1	2.0	2.0-2.0	2-2
	South Korea	1	10.0	10.0-10.0	10-10
	Sweden	1	14.0	14.0-14.0	14-14
	UK	1	1.0	1.0-1.0	1-1
	USA	3	10.0	6.5-12.0	3-14
World Bank					
	High-income	16	6.5	1.75-11.0	1-14
	Upper-middle-income	8	2.5	2.0-4.0	2-7
	Lower-middle-income	2	4.0	2.5-5.5	1-7
WHO					
	Western Pacific (WPR)	15	3.0	2.0-10.0	1-14
	European (EUR)	6	2.0	1.25-2.0	1-14
	Region of the Americas (AMR)	3	10.0	6.5-12.0	3-14
	South-East Asia (SEAR)	2	4.0	2.5-5.5	1-7
Pooled	All countries	26	3.0	2.0-10.0	1-14

IQR, interquartile range.

Reviewers obtained raw data from the primary study for missing data for extraction. Any reference title in the full text review process without an article uploaded was searched and downloaded on the side in PubMed and later uploaded for full text review in Covidence. After the data extraction process, the articles were described in terms of data. References exported from databases were arranged in Endnote software for a primary removal of duplicates. The same was imported to Covidence online software from EndNote for title and abstract screening, followed by full text review and data extraction.

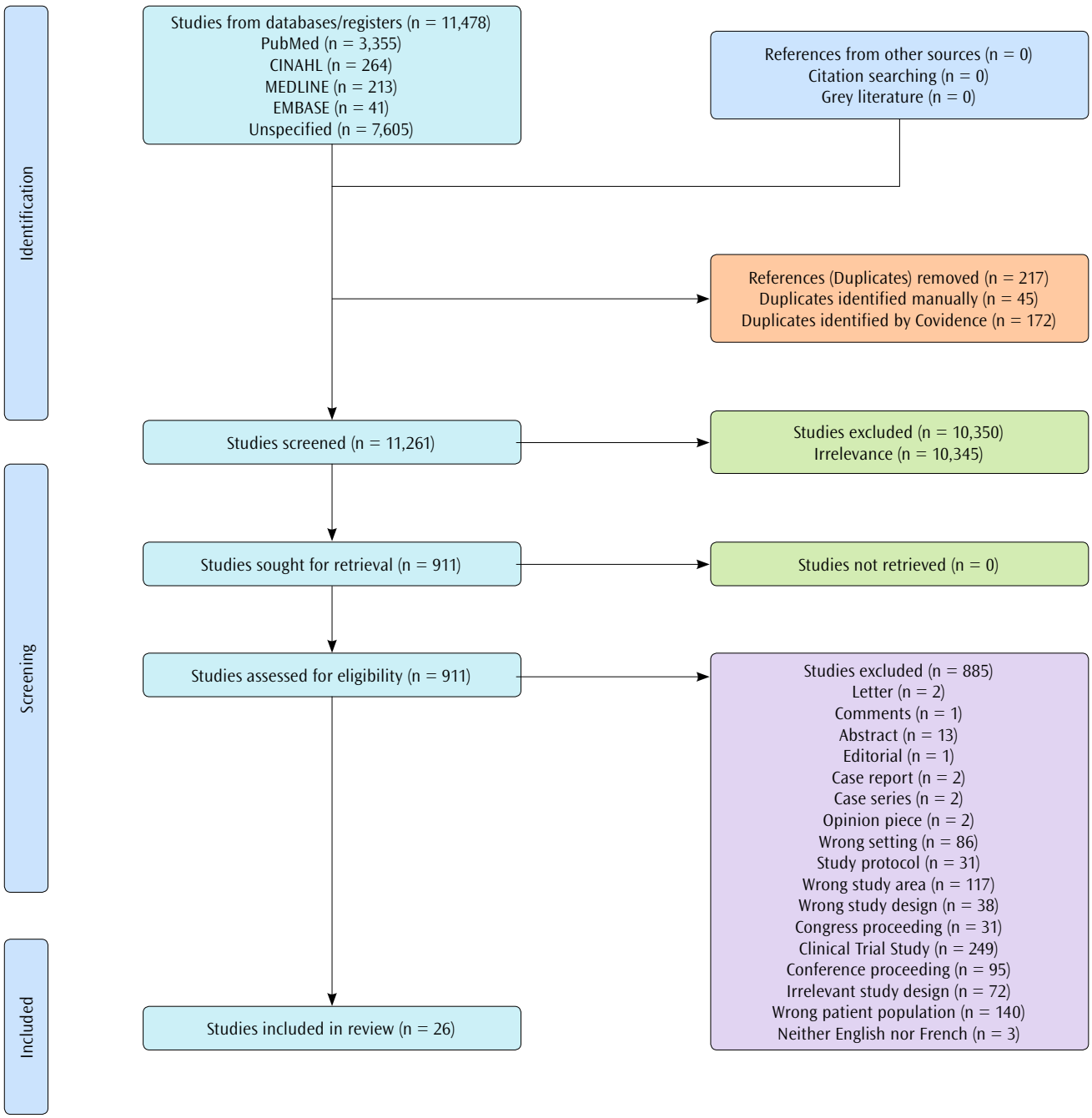


Figure 1. The PRISMA flow chart of selection of studies and their characteristics.

RESULTS

Literature search

A total of 11,478 studies were identified through databases and hand searching strategies. A total of 11,261 studies were screened for title and abstract after an automatic removal of 217 duplicates by Covidence; 911 studies met the inclusion criteria for full-text review, and 26 studies met the inclusion criteria for data extraction. Of the 911 studies in the full-text review, 885 studies were excluded. The detailed delineation of inclusion and exclusion criteria application is shown in Figure 1 of the PRISMA flowchart of studies.

Of the 26 studies included in the scoping review on acute stroke, ischemic stroke was the most studied type of stroke. Seven papers were conducted in China, followed by five papers studied in Japan. For the European Union countries, the review process identified only three studies conducted in Belgium, Denmark, and Sweden. About 61.5% of the studies were randomized controlled studies, 15.3% were observational studies, and 23.0% were comparison studies.

As illustrated in Table 3, data were extracted from studies with the following characteristics: a multi-center, international, randomized-controlled trial study around 56 stroke units in five countries, namely Australia, New Zealand, Malaysia, Singapore, and the UK, was identified. The same study includes Australia and the UK as members of the G20 community. This study concluded that fewer patients in the very early mobilization group had a favorable outcome than those in the usual care group.

A Very Early Rehabilitation Trial (AVERT) study was included during the scoping review process. This study was undertaken to determine whether early and more frequent mobilization after stroke affected health-related quality of life in three countries, including the UK and Australia as part of the G20 countries. This study concluded that early and more frequent mobilization after stroke did not influence quality of life. Moreover, 17 studies were single-center clinical trials with much focus on ischemic stroke. These studies were conducted in Denmark, the United States, China, India, Japan, and Russia.

A quasi-experimental study with a pretest-posttest approach was included in the review process. This study was conducted in Japan with an aim to clarify whether the recovery of upper limb function was enhanced by additionally performing training aimed at improving sensory function on 56 acute hemorrhagic stroke patients.

In the review process, four observatory studies were included for data extraction.[41-44] These studies focused mainly on acute hemorrhagic stroke in Germany, the United States, Australia, and Sweden. They aimed to investigate the association between quality of acute stroke care defined by overall adherence to Evidence-Based Quality Improvement (EBQI) and early outcome in Germany acute care hospitals, to validate subgroups of cognitive impairment on the Montreal Cognitive Assessment (MoCA) and whether they differed in rehabilitation gain during inpatient stroke rehabilitation, to determine the responsiveness of five arm function measures in those receiving acute inpatient stroke rehabilitation; and to estimate the reliability and validity of the Cone Evasion Walk (CEW) test.

The review process identified three comparative studies in Japan and South Korea.[45-47] The purposes of these studies were to compare the performance of three representative instruments to measure changes of motor recovery with acute hemispheric stroke, to compare the outcome of an early application of Neuromuscular Electrical Stimulation (NMES) combined with Traditional Dysphagia Therapy (TDT) versus Traditional Dysphagia Therapy solely, and to investigate the effect of Repetitive Transcranial Magnetic Stimulation (rTMS). See Table 3 for more information on each study illustrated and Appendix 1, the list of G20 countries in detail. This review is context-dependent and multiregional focused. Findings provide a scientifically documented hint regarding the preferably used rehabilitation assessment tools for acute stroke in these model states.

Table 3. Basic characteristics of studies extracted

Reference	Population		Study area & design	Aim of the study	Type(s) of stroke studied	Assessment tool (s) used	Assessment time after the onset
Wang et al.,[48] 2021	Participants (n) Average age (year) Sex: Male Female	209 74 62.7% 37.3%	Study area: China Design: Assessment-blinded randomized controlled trial	To determine the effectiveness of rehabilitation nursing program interventions in patients with acute ischemic stroke.	Ischemic stroke	NIH Stroke Scale, Fugl-Meyer Assessment of Motor Recovery, Modified Rankin Scale, Motor Assessment Scale, Action Research Arm Test and Modified Barthel Index	On day 2
Busk et al.,[49] 2021	Participants (n) Average age (year) Sex: Male Female	50 70 50% 50%	Study area: Denmark Design: Parallel group Randomized Controlled Trial	To determine if early NMES during exercise therapy is superior to exercise therapy alone	Ischemic stroke	Modified Rankin Scale	On day 2
Liu et al.,[50] 2021	Participants (n) Average age (year) Sex: Male Female	86 74 62.7% 37.3%	Study area: China Design: Randomized Controlled Trial	To investigate effects of different intervention time points of early rehabilitation on patients with acute ischemic stroke	Ischemic stroke and hemorrhagic stroke	NIH Stroke Scale, Fugl-Meyer Assessment of Motor Recovery and Barthel Index	On day 3
Haas et al.,[41] 2020	Participants (n) Average age (year) Sex: Male Female	388,012 76 52.4% 47.6%	Study area: Germany Design: Retrospective study	To investigate the association between quality of acute stroke care defined by overall adherence to evidence-based QI and early outcome in German acute care hospitals.	Ischemic stroke	NIH Stroke Scale, Modified Rankin Scale and Barthel Index	On day 1
Wu et al.,[51] 2020	Participants (n) Average age (year) Sex: Male Female	31 61.8 71.0 29.0	Study area: China Design: Pilot, prospective, randomized, controlled study	To develop an early and intense lower extremity training technique using a recumbent cycle ergometer system in patients with acute ischemic stroke	Ischemic stroke	NIH Stroke Scale, Berg Balance Scale, Fugl-Meyer Assessment of Motor Recovery, Modified Rankin Scale and Barthel Index	On day 2
Bornheim et al.,[52] 2020	Participants (n) Average age (year) Sex: Male Female	50 62.98 66 34	Study area: Belgium Design: Randomized controlled trial	To measure the effects of tDCS on functional and sensory outcomes throughout the first year post onset of stroke	Ischemic stroke	Fugl-Meyer Assessment of Motor Recovery and Barthel Index	On day 2
Lin et al.,[53] 2020	Participants (n) Average age (year) Sex: Male Female	143 65.5 63.6 36.4	Study area: China Design: Randomized controlled trial	To investigate the effectiveness of VRT on muscle strength, mood state and functional status in acute stroke patients	Ischemic stroke	Modified Rankin Scale, Barthel Index and Postural Assessment Scale for Stroke	On day 3

Table 3. Continued

Reference	Population		Study area & design	Aim of the study	Type(s) of stroke studied	Assessment tool (s) used	Assessment time after the onset
Jaywant et al.,[44] 2020	Participants (n) Average age (year) Sex: Male Female	329 69.3 55.7% 44.3%	Study area: United States Design: Observational study	To validate subgroups of cognitive impairment on the Montreal Cognitive Assessment whether they differ in rehabilitation gain during inpatient stroke rehabilitation	Ischemic stroke and hemorrhagic stroke	NIH Stroke Scale, Functional Independence Measure and Montreal Cognitive Assessment.	On day 3
Esquenazi et al.,[54] 2020	Participants (n) Average age (year) Sex: Male Female	45 60.3 60% 40%	Study area: United States Design: Randomized, single-blind trial	To evaluate the feasibility of an additional therapeutic ULE intervention in early phase post-stroke rehabilitation To assess outcomes of therapy using the ARMEO Spring versus TAT interventions	Ischemic stroke and hemorrhagic stroke	Fugl-Meyer Assessment of Motor Recovery	On day 14
Obayashi and Takahashi,[47] 2020	Participants (n) Average age (year) Sex: Male Female	19 68.3 67.8% 32.2%	Study area: Japan Design: 10 subjects received 15-20 minutes of rPMS prior to standard care while 9 age- and severity-matched subjects received two times 20 minutes of standard care	To investigate the effects of rPMS	Ischemic stroke and hemorrhagic stroke	Fugl-Meyer Assessment of Motor Recovery, Fugl-Meyer Assessment-Upper Extremity Wolf motor function test and Box and Block Test	On day 14
Cumming et al.,[55] 2019	Participants (n) Average age (year) Sex: Male Female	2,104 70.6 61% 39%	Study area: United Kingdom, New Zealand and Australia Design: AVERT	To determine whether early and more frequent mobilization after stroke affects health-related quality of life	Ischemic stroke and hemorrhagic stroke	NIH Stroke Scale, Barthel Index and Montreal Cognitive Assessment	On day 1
Umeki et al.,[56] 2019	Participants (n) Average age (year) Sex: Male Female	56 65.2 58.9% 41.1%	Study area: Japan Design: A quasi randomized 2-group pretest-posttest	To clarify whether the recovery of upper limb function is enhanced by additionally performing training aimed at improving sensory function	Hemorrhagic stroke	Handgrip dynamometer and Semmes-Weinstein monofilament	On day 10
Iwamoto et al.,[57] 2019	Participants (n) Average age (year) Sex: Male Female	12 61 66.6% 33.4%	Study area: Japan Design: Randomized controlled trial	To assess if upper limb rehabilitation using therapeutic robots improves motor function of stroke patients	Hemorrhagic stroke	Barthel Index and Functional Independence Measure	On day 14

Table 3. Continued

Reference	Population		Study area & design	Aim of the study	Type(s) of stroke studied	Assessment tool (s) used	Assessment time after the onset
Vratsistas-Curto et al.,[42] 2018	Participants (n) Average age (year) Sex: Male Female	64 74 59% 41%	Study area: Australia Design: Inception cohort study	To determine the responsiveness of five arm function measures in people receiving acute inpatient stroke rehabilitation	Hemorrhagic stroke	The Action Research Arm Test, The Upper Limb-Motor Assessment Scale, The Manual Muscle Test, Functional Independence Measure and Functional Independence Measure-Self-Care	On day 2
Na et al.,[58] 2018	Participants (n) Average age (year) Sex: Male Female	76 40.7 63.1% 36.9%	Study area: China Design: Randomized controlled trial	To observe the clinical efficacy of integrated traditional and Western medicine in the treatment of early-stage AIS	Ischemic stroke	Fugl-Meyer Assessment of Motor Recovery and Modified Barthel Index	On day 7
Sjöholm et al,[43] 2019	Participants (n) Average age (year) Sex: Male Female	241 73.3 61% 39%	Study area: Sweden Design: Video recordings of 20 acute stroke patients by 10 physiotherapists up to a total of 400 ratings	To estimate the reliability and validity of the CEW	Hemorrhagic stroke	Cone Evasion Walk test, Functional ambulation classification, Timed Up and Go and Montreal Cognitive Assessment	On day 14
Meng et al.,[59] 2017	Participants (n) Average age (year) Sex: Male Female	123 55.2 50.7% 49.3%	Study area: China Design: Single-blind randomized trial	To assess the efficacy of HABIT on motor functional recovery of the upper extremities in patients with acute stroke as compared to the CRP	Ischemic stroke and hemorrhagic stroke	Glasgow Comma Scale and Fugl-Meyer Assessment of Motor Recovery	On day 2
Alasheev et al.,[60] 2017	Participants (n) Average age (year) Sex: Male Female	90 64.5 52% 48%	Study area: Russia Design: Prospective clinical study	To evaluate NIHSS telestroke assessment, while implementing measures to minimize subjectivity bias	Ischemic stroke	NIH Stroke Scale	On day 2
James and Brammatha,[61] 2017	Participants (n) Average age (year) Sex: Male Female	10 58 100% 0%	Study area: India Design: Experimental study design	To study the immediate effect of gaming assisted visual feedback balance training on balance impairments	Ischemic stroke and hemorrhagic stroke	Berg Balance Scale, Postural Sway, Stance symmetry, Active ankle range of motion and Lateral reach test	On day 7
Guan et al.,[62] 2017	Participants (n) Average age (year) Sex: Male Female	42 58.5 71.5% 28.5%	Study area: China Design: Randomized controlled trial	To evaluate the effectiveness of rTMS on motor recovery after stroke using a prospective, double-blind, randomized, sham-controlled study	Ischemic stroke	NIH Stroke Scale, Fugl-Meyer Assessment of Motor Recovery, Modified Rankin Scale, Barthel Index, The resting motor threshold (MT) of the hemiplegic upper limbs.	On day 7

Table 3. Continued

Reference	Population		Study area & design	Aim of the study	Type(s) of stroke studied	Assessment tool (s) used	Assessment time after the onset
Rabadi et al.,[63] 2017	Participants (n) Average age (year) Sex: Male Female	16 62 100% 0%	Study area: United States Design: Prospective, randomized, double-blind, sham-controlled, trial	To determine whether c-tDCS to unaffected PMC plus conventional OT improves functional motor recovery	Ischemic stroke	Action Research Arm Test	On day 10
Chippala and Sharma,[64] 2016	Participants (n) Average age (year) Sex: Male Female	80 59.9 52.5% 47.5%	Study area: India Design: Single blind, randomized controlled trial	To evaluate the effect of very early mobilization on functional status following acute stroke	Ischemic stroke and hemorrhagic stroke	NIH Stroke Scale and Barthel Index	On day 1
Fujino et al.,[65] 2016	Participants (n) Average age (year) Sex: Male Female	30 66.15 70% 30%	Study area: Japan Design: Randomized controlled trial	To investigate the effects of lateral sitting training on a tilting platform in persons with stroke	Hemorrhagic stroke	Kinematic analysis	On day 10
AVERT Trial Collaboration Group,[66] 2015	Participants (n) Average age (year) Sex: Male Female	2,104 72.5 61% 39%	Study area: Australia, New Zealand, Malaysia, Singapore, and the UK Design: Pragmatic, parallel-group, single blind, multicenter, international, randomized controlled trial	To compare the effectiveness of frequent, higher dose, very early mobilization with usual care after stroke	Ischemic stroke and hemorrhagic stroke	NIH Stroke Scale and Modified Rankin Scale	On day 1
Lee et al.,[46] 2014	Participants (n) Average age (year) Sex: Male Female	57 65 73.8% 26.2%	Study area: South Korea Design: Comparison study	To compare the outcome of an early application of NMES combined with TDT versus traditional dysphagia therapy	Ischemic stroke and hemorrhagic stroke	Functional Oral Intake Scale	On day 10
Seki et al.,[45] 2014	Participants (n) Average age (year) Sex: Male Female	41 62.7 53.6% 46.4%	Study area: Japan Design: Comparative study	The purpose was to compare the performance of three representative instruments to measure changes of motor recovery with acute hemispheric stroke.	Ischemic stroke	NIH Stroke Scale	On day 1

NIH, National Institute of Health Stroke Scale; NMES, neuromuscular electrical stimulation; tDCS, cathodal transcranial direct current stimulation; VRT, virtual reality therapy; TAT, task-specific activity training; rPMS, repetitive peripheral magnetic stimulation; AVERT, A Very Early Rehabilitation Trial; AIS, acute ischemic stroke; CEW, Cone Evasion Walk test; HABIT, Hand-Arm Bimanual Intensive Therapy; CRP, C-reactive protein; NIHSS, National Institute of Health Stroke Scale; c-tDCS, cathodal transcranial direct current stimulation; OT, occupational therapy.

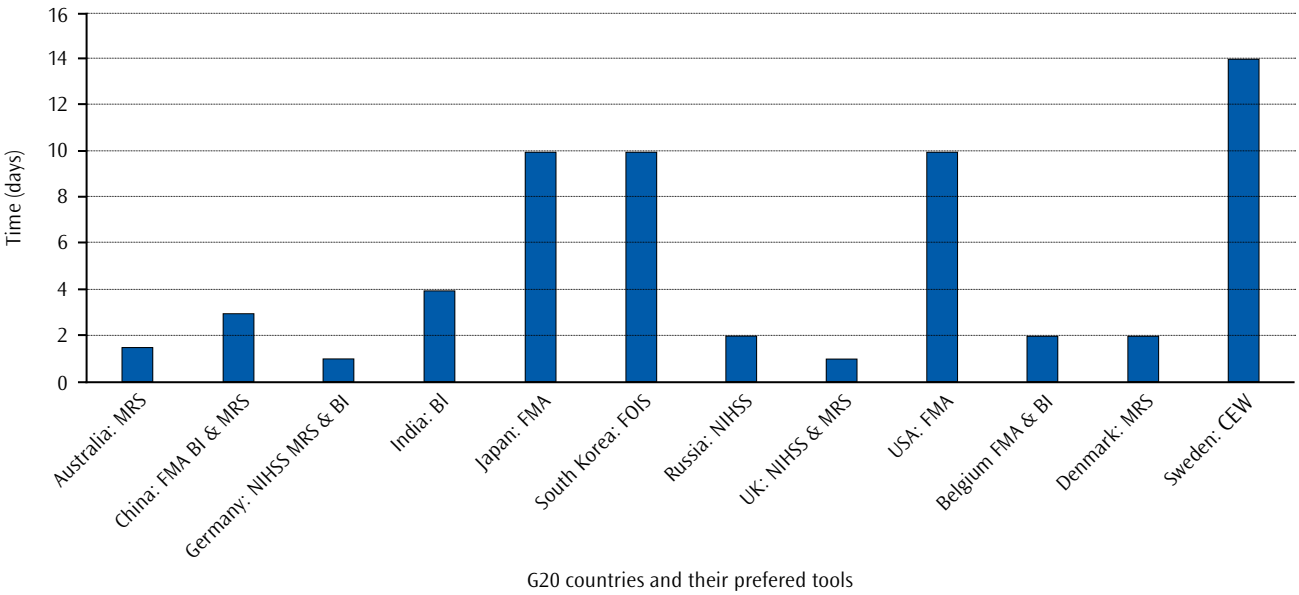


Figure 2. The delay median time of assessment and tools preferred per identified G20 countries.

MRS, modified Rankin scale; FMA, Fugl-Meyer assessment; BI: Barthel index; NIHSS, National Institutes of Health stroke scale; FOIS, functional oral intake scale; CEW, cone evasion walk test.

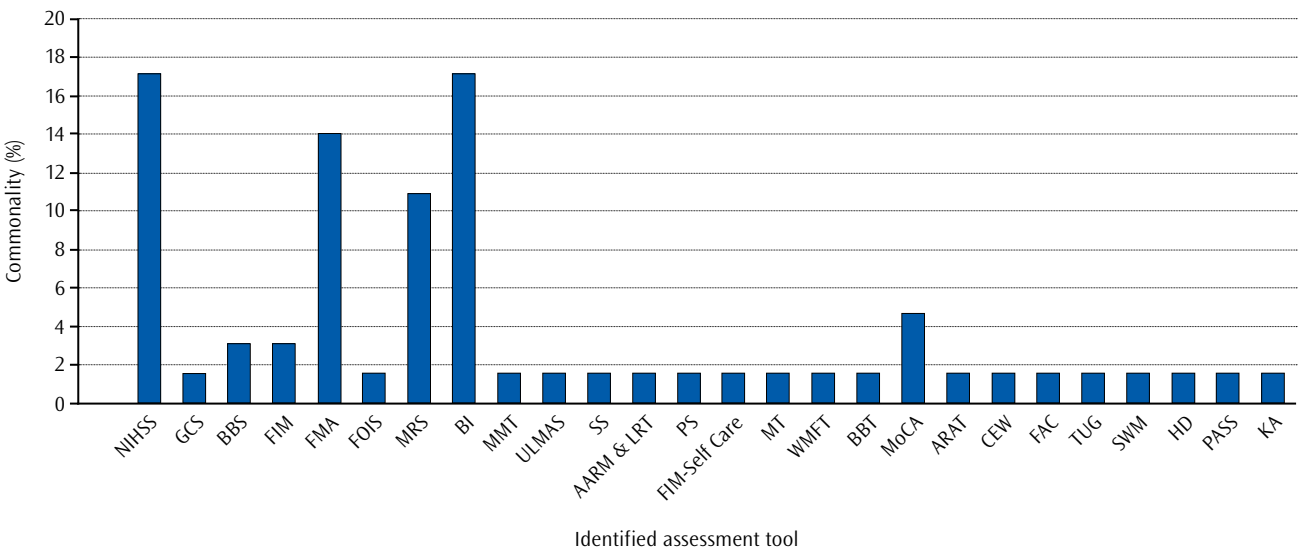


Figure 3. The commonality of the identified tools for acute stroke assessment in the G20 countries.

NIHSS, National Institutes of Health stroke scale; GCS, Glasgow coma scale; BBS, Berg balance scale; FIM, functional independence measure; FMA, Fugl-Meyer assessment; FOIS, functional oral intake scale; MRS, modified Rankin scale; BI, Barthel index; MMT, manual muscle testing; ULMAS, upper limb motor assessment scale; SS, stance symmetry; AARM & LRT, active ankle range of motion and lateral reach test; PS, postural sway; FIM-Self Care, functional independence measure-self-care; MT, resting motor threshold; WMFT, Wolf motor function test; BBT, box and block test; MoCA, Montreal cognitive assessment; ARAT, action research arm test; CEW, cone evasion walk test; FAC, functional ambulation classification; TUG, timed up and go; SWM, Semmes-Weinstein monofilament; HD, handgrip dynamometer; PASS, postural assessment scale for stroke; KA, kinematic analysis.

Assessment tools

This scoping reviewed 26 assessment tools identified from 26 studies across 43 member states making up the community of G20 countries. See Table 3; assessment tools were identified from 26 studies for G20 countries, including Australia (n = 2), Germany (n = 1), Japan (n = 5), India (n = 2), UK (n = 1), Denmark (n = 1), China

(n = 7), Belgium (n = 1), Russia (n = 1), United States (n = 3), South Korea (n = 1), and Sweden (n = 1). In Figure 2, the median time post-stroke at which the assessment was carried out is reported for each of the countries and under classifications.

The assessment tools used and their commonality in the G20 countries

Twenty-six assessment tools for acute stroke rehabilitation assessment were identified in the review process. As indicated in Table 3, a total of 394,120 acute stroke participants were included in the studies. The mean age of participants was 65 years, of which 64.1% were males. Among the identified studies, the commonly used acute assessment tools are the National Institute of Health Stroke Scale (NIHSS), the Fugl-Meyer Assessment of Motor Recovery (FMA) as the motor functioning assessment tool, and the Barthel Index (BI) as an outcome measure scale. Figure 3 shows the acute stroke assessment tools most preferred in the first two weeks (14 days) of admission and their commonality across the G20 countries. Out of the 64 tools that were identified across the 26 studies, the frequency of NIHSS, BI, and FMA was 11 (17.2%), 11 (17.2%), and nine (14.1%), respectively, as the commonality score.

The assessment time of acute stroke

Across the 26 included studies, assessment tools were applied at six-time points namely, as shown in Figure 4. The median reported time to the first application of assessment tools after stroke onset/admission was 3 (IQR, 2 to 10) days. This indicated that the application of assessment tools within the first three days after stroke was reviewed in around 50% of included studies.

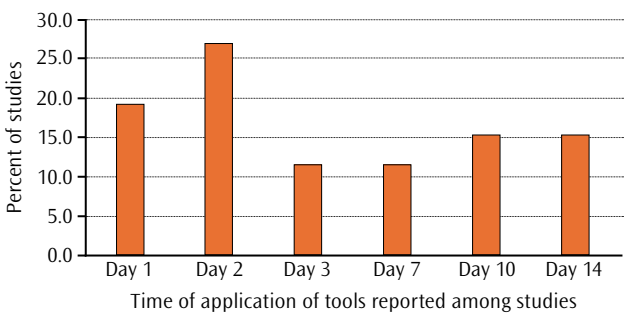


Figure 4. The timing of assessment tools application after stroke onset across studies.

A total of 16 studies were from HICs, eight from UMICs, and two from LMICs in consideration of World Bank classification. By WHO region, 15 studies were from the Western Pacific Region, six from the European Region, three from the Region of the Americas, and two from South East Asia. The assessment time ranged from 1 to 14 days across studies. As shown in Table 2, the World Bank income group median time was 6.5 (IQR, 1.75 to 11) days for high income, 2.5 (IQR, 2 to 4) days for UMICs, and 4 (IQR, 2.5 to 5.5) days for LMICs. The WHO region medians were 3 (IQR, 2 to 10) days for the Western Pacific Region, 2 (IQR, 1.25 to 2.0) days for European regions, 10 (IQR, 6.5 to 12) days for the region of the Americas, and 4 (IQR, 2.5 to 5.5) days for the South-East Asia Region.

In non-parametric comparisons, there was no significant difference in evaluation time between HICs and UMICs (p = 0.51) or between the Western Pacific and European regions (p = 0.19). Exploration Kruskal-Wallis tests showed no significant overall differences across the three-income group (p = 0.61) or four WHO regions (p = 0.23).

As shown in Figure 2, Germany preferably uses NIHSS, modified Rankin Scale (mRS), and BI assessment tools for acute stroke. The median time for acute stroke assessment is within the first day after the onset/admission of stroke symptoms. In the UK, NIHSS and BI are preferred assessment tools applied in the assessment on the first day of onset/admission. In Australia, mRS is the preferred tool of assessment used in the first 1.5 days after the onset/admission of stroke symptoms. The review process identified that Russia prefers using the NIHSS assessment tool. The assessment using the same tool was on Day 2 after the onset/admission. In China, the assessment tools preferred the most are FMA, BI, and mRS. The start of assessment using the same tools was 3 days after the onset/admission. The assessment of patients in Belgium was on Day 2 with a preference for FMA and BI tools. In Sweden, the median time was on Day 14, with a preference for the mRS tool, while Denmark on Day 2 with a preference for CEW tools, as shown in Figure 2. In India, BI is the preferred tool for acute stroke assessment. The median time of tool application

was on Day 4 after the onset/admission. The FMA is the most preferred tool in Japan and applied in the first 10 days after the onset/admission. In the United States, the median assessment time was 10 days, and the most preferred tool after the onset/admission of stroke symptoms is FMA. In South Korea, Functional Oral Intake Scale (FOIS) is the assessment tool used, applied on Day 10 after the onset/admission of stroke symptoms.

Besides the median time per country as shown above, the review process found that the median time for acute stroke assessment in the G20 community was 3 days after the onset/admission of stroke symptoms.

DISCUSSION

This scoping review identified substantial variation in the tools and timing used for acute stroke rehabilitation assessment across the G20 countries. The review was interpreted using the 2014 WSO Global Stroke Services Guidelines and Action Plan, which provides an international framework for organized stroke care across the continuum from acute treatment to rehabilitation and community integration. The NIHSS, FMA, and BI were the most frequently reported tools to assess different aspects of recovery namely neurological impairment, motor impairment, and independence in basic activities of daily living, respectively. The pooled median assessment time was 3 (IQR, 2 to 10) days after stroke onset or hospital admission, indicating that assessment was often undertaken early, but was not applied consistently across studies.

The frequent use of NIHSS, FMA, and BI suggests that acute stroke rehabilitation assessment commonly focusses on impairment and basic functional ability. However, no single tool provides a complete assessment of rehabilitation needs. The NIHSS is suited for neurological assessment,[67] the FMA assesses motor function,[68] and the BI assesses independence in basic activities of daily living and mobility,[69] Comprehensive rehabilitation assessment should also consider communication, cognition, swallowing, mood, participation, caregiver support, and environment factors. This broader approach is consistent with the WSO framework, which emphasizes early identification of rehabilitation needs, functional assessment, individualized rehabilitation planning, and multidisciplinary care across different resource settings.

The timing of assessment differed across included studies. The NIHSS was usually reported within the first one to two days in studies from Germany, the UK, and Russia.[41,60,70] The BI was reported between one and four days in studies from Germany, China, India, and Belgium,[41,52,53,64] whereas the FMA was reported between one and 10 days in studies from Belgium, Japan, and the US.[47,52,54] Considering the preference of these tools, their small percentages as identified in this review reflect the distribution of commonality across other assessment tools identified in the review process.

Differences in the timing of tool application across G20 countries also reflect variation in clinical priorities, healthcare system organization, rehabilitation workforce capacity, and referral pathway. In some settings, rehabilitation professionals may be involved early during acute admission, whereas in others, detailed motor assessment may occur only after transfer to a rehabilitation unit or once the patient is medically stable. These differences may help explain the observed variation in assessment timing, although they cannot be confirmed from the available evidence.

The pooled median time of 3 (IQR, 2 to 10) days suggests that many patients receive assessment during the early phase of stroke care. This finding is broadly consistent with the WSO emphasis on early identification of rehabilitation needs and timely access to appropriate stroke services. However, the upper quartile of 10 days indicates that assessment was delayed in substantial proportion of studies. Delayed assessment may postpone the identification of rehabilitation needs, goal setting, treatment and discharge planning. Differences in timing may be related to service organization, workforce availability, patient clinical stability, referral procedures, and variation in how studies defined and or reported the first assessment.

Variation was also observed across WHO regions and country-income group. Studies

from the European Region reported the earliest median assessment time, while long times reported in some studies from the region of the Americas and Western Pacific Region. Upper-middle-income countries, represented mainly by China, reported a median assessment time of 2.5 days. The two studies from India, classified as a LMIC setting, reported a median of 4 (IQR, 1 to 7) days. These findings suggest that early assessment is feasible across countries with different income levels. However, the limited number of studies prevent firm conclusions about differences between countries, regions, or income groups.

The WSO framework classifies stroke services as minimal, essential, or advanced according to available resources, infrastructure, and personnel,[19] The WSO framework classifies stroke services as minimal, essential, or advanced according to available resources, infrastructure, and personnel,[19] The variation observed in this review may, therefore, reflect differences in the level and organization of stroke services, the availability of trained rehabilitation professionals, and access to standardized assessment tools. However, as the included studies did not directly assess WSO service level or guideline adherence, these explanations remain tentative.

The WSO practical resource consistently recommends that rehabilitation assessment and referrals should be considered within 48 h of admission after medical stabilization. The findings of this review show that early assessment varied widely. This variation limits comparison across settings and makes it difficult to determine whether patients receive timely and comprehensive rehabilitation assessment. Further studies should distinguish between neurological severity screening, impairment, functional assessment, and comprehensive multidisciplinary rehabilitation assessment. They should also clearly report whether assessment timing is measured from stroke onset, hospital arrival, stroke unit admission, medical stabilization, or rehabilitation referral. Standardized reporting would improve comparability across studies and support more consistent acute stroke rehabilitation pathways across countries.

A key strength of this scoping review was the independent screening of titles and abstracts by two health professionals, with disagreements resolved by a third reviewer. Similarly, full-text data extraction was performed independently by two health professionals, with conflicts resolved through third-party adjudication. Another methodological strength was the use of study-level data to assess the timing of rehabilitation assessments, preserving within-country variability and enabling more appropriate grouping according to World Bank and WHO classifications. Furthermore, non-parametric statistical methods were employed, given the skewed distribution and relatively small sample sizes.

Nonetheless, there are several limitations to this scoping review. First, the relatively small number of included studies (n = 26) and their uneven geographical distribution limited the representativeness of the findings. Several regions, including the African and Eastern Mediterranean regions, were not represented, resulting in the underrepresentation of several G20 countries and WHO regions. Second, the included studies inconsistently defined the starting point of rehabilitation assessment, reporting either time from stroke onset or time from hospital admission. Therefore, these data were collectively reported as onset/admission, which should be considered when interpreting the findings. Third, although several biomedical, rehabilitation, nursing, and allied health databases were searched, Scopus was not included due to resource constraints. In addition, the review was restricted to full-text, peer-reviewed publications in English or French and did not include grey literature. These restrictions may have resulted in the omission of relevant publications, emerging assessment tools, and context-specific rehabilitation practices, particularly from underrepresented G20 countries. Accordingly, the findings should be interpreted as a map of the available published evidence rather than a comprehensive representation of acute stroke rehabilitation practices across all G20 countries.

In conclusion, this scoping review provides an overview of current assessment practices in acute stroke rehabilitation across G20 countries and emphasizes the importance of timely and

structured assessment in guiding rehabilitation care. The findings demonstrate the continued use of established assessment instruments for evaluating neurological impairment, motor recovery, and functional independence, while revealing variations in the timing and implementation of rehabilitation assessments. Although no statistically significant differences were identified across the represented income groups or WHO regions, the observed variations suggest potential gaps between guideline recommendations and their implementation in clinical practice. Addressing these gaps requires strengthening early rehabilitation pathways, promoting the consistent use of validated assessment tools, and establishing standardized approaches to reporting assessment timing. These efforts should be prioritized across both HIC and LMIC settings to support equitable and evidence-based stroke rehabilitation practices. Further multi-national research with broader geographical representation and harmonized assessment protocols is warranted to better understand differences in clinical practice and inform the development of globally applicable strategies for early stroke rehabilitation.

Declaration of Conflicting Interests

The authors declare that there are no conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Author Contributions

M.C.S., C.C., R.R., A.S., NR.: Idea/concept, design; C.C., M.C.S., A.S., R.R.: Control/supervision; N.R., C.C.: Data collection and/or processing, literature review; N.R., C.C., M.C.S., A.S., RR.: Analysis and/or interpretation, writing the article, critical review; N.R.: References.

Data Availability Statement

The data supporting the findings of this study are available in Mendeley Data at https://doi.org/10.17632/cns53m7zzz.2. The dataset is under embargo and will be publicly available on 13 December 2026.

AI Disclosure

The authors declare that artificial intelligence (AI) tools were not used, or were used solely for language editing, and had no role in data analysis, interpretation, or the formulation of conclusions. All scientific content, data interpretation, and conclusions are the sole responsibility of the authors. The authors further confirm that AI tools were not used to generate, fabricate, or 'hallucinate' references, and that all references have been carefully verified for accuracy.

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