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Research, Education and Practice of Tele-Neurorehabilitation in Low and Middle-income Countries - A Scoping Review

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Abstract:	BACKGROUND: Tele-neurorehabilitation (TNR) allows for remote delivery of rehabilitation services for those with neurological disabilities. Despite growing global interest and uptake, its adoption remains challenging in Low-and-Middle-Income-Countries (LMICs) OBJECTIVE: To explore available literature on the nature of training and education, research and practice of TNR in LMICs METHODS: Following PRISMA-ScR guidelines, and predefined selection criteria, 4 databases were screened. Quality assessment was performed using theJoanna Briggs Institute tools. Relevant data was extracted to using a data extraction form in Microsoft Excel and were narratively synthesised under Education/training, Research and Clinical Practice of TNR. RESULTS: We identified no formal structured training courses/programme for TNR users/providers. A majority of sessions were delivered as part of a research project. The included studies highlighted the need of engaging stakeholders in TNR research and improving digital-literacy among healthcare providers/users. Development and use of clinical decision-making-tools, models of TNR suitable for varied populations, prior area-mapping were a few suggestions for clinical/research practice

	CONCLUSIONS: There is an immense need to develop academic/structured programmes for TNR to build capacity among providers/users in LMICs. Practice must adhere to principles of safety, effectiveness, and based on high quality clinical-guidelines suitable to the context to ensure optimal uptake and practice of TNR in LMICs.

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Introduction:

Telehealth has received global acceptance by policymakers and clinicians, especially after the COVID-19 pandemic.[1] Tele-neurorehabilitation (TNR) is an essential component of telehealth that provides a valuable opportunity for delivering rehabilitation services for those with neurological disabilities using information and communication technologies.[2] The use of both asynchronous and synchronous TNR approaches has the potential to provide an advantage of facilitating continuum of rehabilitation services for those with neurological disabilities living at home, and other community settings.[3] There is growing evidence that TNR is cost-effective [4] and can be employed in patient consultation, health assessment, patient education, patient monitoring, therapy administration, and follow-up of interventions and supervision. [5] Although not a new concept, it is not well embraced and implemented due to social and economic barriers in the provision of rehabilitation care and access to good quality comprehensive neurorehabilitation services.[6] Several studies have reported on telerehabilitation (TR) in neurological conditions[2, 7, 8] with systematic reviews highlighting the cost benefits with improved outcomes.[7]

Despite the growing global interest in digital health strategies such as the adoption of TNR, in Low-and-Middle-Income-Countries (LMICs), there are associated challenges, besides the aforementioned, in educating, researching and practicing TNR.[9] Evidence states that both providers and consumers face simple to complex barriers not limited to poor understanding of technology used,, scepticism about the use of such a mode of therapy, poor internet connectivity, unavailability of competent clinicians/suitable outcome measures that can be used remotely to deliver an effective TR session.[10, 11] Additionally, it is also unclear how the evidence for TNR is implemented or evaluated in LMICs. One of the major challenges reported in LMICs is the lack of training both in academic curriculum and clinical practice, with rare to complete absence of practice guidelines for TR/TNR.[12, 13] This lack of training and absence of a reference framework guiding TNR practice undoubtedly contributes to heterogeneity in practice and poor delivery of rehabilitation services for those who could benefit from such interventions.[14] This in turn may be associated with the lack of research and funding directed towards building the capacity for TNR in LMICs. Therefore, in this review, we aim to explore the available literature on the nature of training, research and practice of telerehabilitation in neurological conditions in LMICs.

Methodology:

Design

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews (PRISMA-ScR) was used for this scoping reviewo identify, synthesise and report data on education, research and practice of TNR in LMIC.[15] Joanna Briggs Institute (JBI) critical appraisal tools were used to appraise the methodological quality of the included studies v [16]

Identifying Relevant Studies

The following electronic databases were searched for eligible articles from August 2013-August 2023: Medline, EMBASE, CINHAL, PEDro, ProQuest and Scopus. A search strategy that considered relevant index terms and keywords was developed based on PICo format[17] (Supplementary material 1). The search strategy for MEDLINE was adapted for searches into other included databases by DG, NC and JVD. References identified from previous reviews and included papers were also screened.

Study selection

The criteria for the selection of studies were predefined. Experimental studies, observational studies, reviews and meta-analysis published in the last 10 years on TNR (August 2013-August 2023) reported from LMICs, describing methods, checklists for TNR sessions, protocols, requirements, and outcomes on education and/or research in neurological rehabilitation for adult neurological conditions with a focus on users & providers, explaining any type or mode of telerehabilitation were included. However, studies on home-based robotics, virtual reality, and game-based therapy regimes for neurological rehabilitation were excluded if they did not have the TNR components of follow-up, remote monitoring /delivery of therapy sessions.

Rayyan web tool was used for duplicate removal, screening and article selection.[18] Titles and/or abstracts were screened by DG, NSC, JVD, PJV, SZ, AM and potentially eligible full texts were reviewed independently by AM & NSC based on the predefined selection criteria described above. In case of disagreement, consensus was reached with a third reviewer (JS).

Data extraction:

A customized data extraction form was developed on Microsoft Excel where six reviewers (DG, VM, SK, EN, SZ & NSC) independently extracted data from the included studies on the

title of the study, country of origin, type of study design, type of technology used (app, online calling platforms like zoom/teams etc, remote monitoring with sensors/cameras etc, websites, messages/SMS, others), purpose (Assessment, intervention, training of providers etc) and target audience of the telerehabilitation session, timing of telerehabilitation delivery (synchronous, asynchronous, continuous), Domain (PT, OT, SLP etc) & dosage of the session, details of education provided, research related tips, outcome measures used, mention of practice guideline related to telerehabilitation and documented it.

Data Synthesis or Charting:

Data from the included articles was narratively synthesised under the following themes.

- *Education on TNR*
- *Research on TNR*
- *Clinical Practice of TNR*

Results:

A total of 952 records were screened and18 studies were included - in this scoping review (Figure 1). In terms of the neurological conditions majority of studies were on stroke (n=6), followed by Parkinson's disease (PD) (n=3) and Spinal Cord Injuries (SCI) (n=2), with the rest on composite neurological conditions (n=3), stroke and cerebral palsy (CP) (n=1), SCI and Acquired Brain Injuries (n=1), SCI and Stroke (n=1) and Dementia (n=1). For the study that included both Stroke and CP we have only taken the data related to adults, as the data for those with cerebral palsy was from the paediatric population. Included studies were from India (n=2), Philippines (n=2), Indonesia (n=2), Pakistan (n=1), China (n=1), Peru (n=1), Ghana (n=1) and Nepal (n=1) but most studies focussed on a group of countries categorised as LMICs or Southeast Asia (n=7)

In terms of the study designs, eight studies were empirical (experimental trials, cross-sectional studies, pre-post design studies), seven were systematic, non-systematic or scoping reviews, three were case reports/series. The characteristics of the included studies are provided in Table 1. Table 2 provides the JBI scoring/critical appraisals of each of the included studies.

The results have been presented under three themes namely (1) Education and Training, (2) Research and Scope of Practice (3) Recommendations for research & clinical application of TNR as reported in the included studies,

1. *Education and Training required for users and providers for TNR delivery:*

a) *Training of service providers:* Most sessions on training were delivered as part of a research project. No studies so far have identified and reported on structured training courses or academic programs for TNR. Yan and colleagues in a 2-arm cluster RCT, reported training of village doctors on the specifics of the SINEMA app used for secondary prevention of stroke along with a follow-up refresher training. The app aided the village doctors in follow-up procedure of the study sample, collection and storage of relevant information.[19] Similarly in Ghana, Physiotherapists received structured training on the 9zest Stroke App® system for providing stroke rehabilitation with remote supervision, in addition to training on assessing patient eligibility for this TNR. Their competencies were assessed following training.[20] A review reported study conducted in Cameroon that used a web based educational material on a learning platform for training competencies of professionals treating individuals with movement disorders. These professionals received training sessions for a year through video conferences delivered by experts in the field.[21]

b) *Training of users:* A review in 2022 discussed various modes of technology-based rehabilitation for stroke including TNR in the South-east Asian region. It underscored the value of using pre-participation screening tools to participate in the TNR session.[22, 23] Subsequently, the use of tele-practice questionnaire, in this study and in a case report from Philippines[24], measurement of perception and acceptance of the TNR sessions among users were completed. Another interventional study from the Philippines used in-person baseline assessments for deeming patient fitness for mobility sessions via TNR and in the hospital.[25] Patient/caregiver readiness criteria checklists have also been used prior to inclusion into the studies.[26] Such training among users is essential for appropriate choice of patients for TNR. A study for SCI rehabilitation in India by Tyagi et al emphasized the need for TNR training among users and motivation to embrace this mode of rehab by using customized guidance, reminders video-based training solutions.[27] An interventional study on home-based exercise program for those with Dementia, conducted in Indonesia, followed a structured training program for participants in the use of zoom platform. This training included an online orientation session, camera and sound testing, setting the device distance and the environment in which exercises will be performed and safety measures during the regime. Additionally periodic online follow-ups made the intervention feasible. [28] In another study, stroke survivors received instructional videos on a social media platform and instructions and clarifications from the telerehabilitation team was established through various private

and group chats.[25] In a review by Solomon RM et al on TNR for those with SCI in LMICs, it was noted that none of the included studies reported difficulty among participants in using TNR or telemedicine related equipment. Whether this is an oversight or actual absence of difficulty in using TNR is debatable.[29] In their review Garg D et al describe a combination of synchronous and asynchronous modes of TNR for those with Parkinson's which included safety measures like exercises at moderate exertion levels as measured on Borg's scale, during the 'ON' phase of drugs, maintain a log of exercises videos which were performed without supervision.[30] One study additionally had a feature in its TR program of the option to refer its participants to a nearby hospital if needed, suggesting the need for detailed planning and networking for a TNR to be useful.[31]

2. *Research and Scope of Practice in TNR*: Most of the studies included in this review quoted that they followed guidelines on TNR from High Income Countries (HICs). American Telemedicine Association has developed a Guide to Telehealth covering aspects like technology, Clinical, Financial, Communication, and Metrics after the COVID-19 Pandemic. It covers a range of areas like core operational guidelines for patient-provider interactions, telepathology, telestroke, videoconferencing-based telemental health and TR among a cascade of other areas (https://www.americantelemed.org/resource_categories/practice-guidelines/). Various researchers have presented the need for engaging stakeholders in TNR initiatives to ensure that such programs align with the needs of the users with subsequent integration of such comprehensive programs into healthcare systems.[20] Components on improving digital literacy among healthcare providers and users are also identified as an immediate need that should be recommended in national or institutional guidelines. Similarly, certain LMIC CPGs for stroke rehabilitation like Cameroon, South Africa and Ukraine merely state the role of TNR in remote assessment & rehab monitoring in the absence of or difficulty in in-person rehabilitation. (DBC Gandhi et al, 2023, Unpublished data).

3. *Recommendations for research & clinical application of TNR (Figure 2):*

The included studies provided various solutions that TNR faces currently especially with the focus of improving clinical practice in TNR. One of the studies recommends construction of primary care-based models emphasizing on provider-patient interactions, targeting specific

neurological disorders.[28] A focus on training programs for both providers and users is recommended, to enhance proficiency in TNR delivery, technology utilization, to refine clinical competencies with special emphasis on communication skills specific to TNR.[20, 27] Strengthening TNR with clinical decision-making tools for providers is another unique recommendation that is seldom discussed.[32] Baretto M et al describe the need for building and using conceptual models of group TNR that are adaptable to different groups, capacity building, and collaboration with diverse stakeholders such as NGOs, local healthcare facilities and government bodies to secure resources and infrastructure essential for TNR programs.[33] To judiciously use local resources and ensure convenience/accessibility to rehabilitation, Marlina M et al recommend area mapping techniques to identify accessible locations for group TNR, particularly in remote or rural areas.[26] Highlighting TNR's role in mitigating geographical constraints, reducing travel expenses and enhancing accessibility in resource limited settings and in addressing affordability concerns is another way to improve its use.[24] Subsequently promotion and expansion ofusing cost-effective technologies such as social media apps in TNR initiatives, particularly in LMICs, to ensure adaptability to local infrastructures would be beneficial.[25, 31] Lastly, it is also crucial to implement education and training programs to improve digital literacy among healthcare providers and patients, while systematically addressing initial concerns about TNR among stakeholders through gradual acceptance-building initiatives.[13]

Discussion: This review has provided very useful insights into the education, research, and practice of TNR in LMICs. Studies included in this review showed that education for TNR has been focusing on both service providers and service users. The training aspects from the included studies indirectly acknowledge the need for ensuring standards for TNR practice. They have adopted guidelines from HICs to reinforce the significance of such standards in building the capacity for TNR. The importance of co-production and bridging the research gaps in TNR was also thoroughly discussed. Some examples of TR programs & toolkits from HICs are provided in Supplementary Material 2.

Future needs in TNR training: There are several areas for improvement. Most of these trainings have focused on helping the TNR users on how to navigate through the technology that was developed rather than training them to optimize digital technology for neurorehabilitation.[34, 35] Importantly, none of the included studies have reported on formal training programs for undergraduates and postgraduate health and allied health students in their academic curriculum. Without instilling the need and significance of TNR in formal education, building the capacity

for TNR among users (consumers and providers) can be challenging.[36] *Inclusion of training in academic curricula:* Studies emphasized the need for integrating TR into academic curricula and continuous training for healthcare professionals.[36] Yet, the extent of integration and the actual impact on practice remained underreported, indicating the need for thorough evaluation of these strategies.

Need for context-specific guidelines: Most studies relied on guidelines from HICs, indicating a prevalent gap in locally developed and applicable guidelines for TNR in LMICs. While these included studies emphasized the need for guidelines tailored to the local context, they also highlighted the challenges in integration due to limited digital literacy among healthcare providers.[37]

Co-design in developing technology and guidelines: The recommendation for engaging stakeholders and enhancing digital literacy resonates strongly with the need for immediate action to bridge this gap for successful TR implementation.

The recommendations from included studies strongly advocate for service users involvement in designing, developing and implementing TNR services in LMICs.[38] Studies suggesting for user-centered design, such as the mHealth app development for stroke rehabilitation and the BYM tool for Parkinson's patients, underscored successful interventions tailored to the needs and preferences of the users. These initiatives involving users in the development process led to more user-friendly solutions. However, the absence of reported difficulties in some studies might not fully represent the actual challenges faced by diverse user groups, highlighting the need for engaging service users in the co-designing and co-production of TNR interventions, particularly in LMICs where resources for rehabilitation are very limited.[39]

Economic and financial sustainability: Technical challenges, highlighted by studies like those discussing TR for stroke survivors, showcased both the promise and pitfalls of utilizing advanced technology.[25] While studies lauded the ease of learning and flexibility for home use, technical issues such as time-consuming setups, disruptions, and limited physical space were reported. These findings underscore the importance of developing robust, user-friendly technology suited to local infrastructure realities. Studies proposing sustainable subscription models, like the outREACH system for LMICs, presented promising strategies for financial sustainability.[40] However, the actual implementation and success of such models remain underexplored, necessitating further research to determine their feasibility and scalability in diverse settings.

Understanding determinants to TR/TNR: According the UTAUT 2 model (Unified Theory of Acceptance and Use of Technology), which is a framework to measure technology use and adoption, various factors influence the acceptance and use of TR, such as performance and effort expectancies, behavioral intentions and use, social influences, facilitating conditions and hedonic motivation. Efforts need to be made to take these factors into consideration while assessing and using Telerehabilitation.[41]

Global picture and research: Global adoption of telehealth, especially telerehabilitation, has grown, especially in the wake of the COVID-19 pandemic.[34] With an emphasis on practice, research, and training, this review investigates the particular requirements for the effective development and implementation of TNR in LMICs.

Competency and skill-building surfaces as a central theme, frequently provided as a component of research initiatives. As an illustration, consider teaching physiotherapists about stroke rehabilitation apps and village doctors about applications that prevent strokes. Training courses cover a wide range of neurological disorders, highlighting the necessity of specialized skills.[42] There are many different types of training interventions available, including as home-based fitness programs for Parkinson's patients, organized programs for dementia patients on Zoom, and therapies for spinal cord injuries in India.[34] Adherence to prescribed activity levels, safety protocols, and regular follow-ups emphasize how structured these programs are. These aspects imply the need for inclusive research and systematic development of innovation TNR interventions that meets the needs of service users and ensure good quality, safe and effective rehabilitation is provided to people with neurological disabilities.

Strengths of the review & future scope: The findings of the review underscore the critical need for targeted recommendations to overcome challenges and optimize the implementation of telerehabilitation programs. These recommendations serve as a strategic roadmap to enhance the efficacy and sustainability of telerehabilitation initiatives, particularly in the context of LMICs. Models of telerehabilitation become essential instruments for enhancing research and knowledge generation.[43] The authors emphasize on the significance of continuous training initiatives while acknowledging the critical role that capacity building plays. These programs target end users and other pertinent stakeholders in addition to healthcare providers. The study also highlights how important it is to actively engage with stakeholders, such as communities, healthcare organizations, and policymakers. Through their involvement, telerehabilitation programs can be sustainably integrated into the current healthcare frameworks, creating a supportive ecosystem. This paper has explored the various areas where institutions or

rehabilitation professionals can gauge their TNR services broadly and provides a direction for improving TNR implementation and use in the future.

Conclusion:

Overall, this review provides key implications for education, research and practice of TNR in LMICs. There is an immense need to develop academic or structured programmes for TR or TNR to build the capacity of the providers of TNR in LMICs. Practice must adhere to the principles of safety, effectiveness, clinical guidelines suitable to the context and quality to ensure people with disabilities requiring TNR get it with the utmost quality and standards. Additionally, comprehensive reporting and thorough evaluation using appropriate research design and sufficiently powered research studies with representative population is necessary to bridge the gaps in evidence for TNR in LMICs.

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Sl no	**AUTHOR/ YEAR and Country**	**Neurological Condition**	**Type of Study**	**No. of participants/studies included**	**Tele-medium/ devices**	**Training Setting**	**Synchronous/ Asynchronous Delivery**	**Domain Addressed**	**Dosage/No of hours**	**Caregiver/ Patient Involvement**
1	Yan LL et, 2021, China	Stroke	2 arm cluster RCT	1,226	mHealth technology, including an Android-based app (SINEMA App) for follow-up visits, and a daily voice messaging system.	Primary care-based integrated mHealth intervention	Synchronous	NS	1 day training to use app Refresher training at 3rd month	Both
2	Babur MN, 2022 Pakistan	Stroke, SCI, Parkinson's	Review	NS	NS	NS	NS	NS	NS	NS
3	Shalash A, 2021, Global	Parkinsons	Review	NS	Video calls, phone calls, emails, texts, WhatsApp, Zoom, Skype, wearable technologies, mobile applications.	Training & education programs in Cameroon	Both	NS	NS	Patients
4	Ganapathy K, 2020 Global	Neurological conditions	Review	NS	Audio and Video equipment, WhatsApp, Zoom, Microsoft Teams, and Google Forms	NS	Both	NS	NS	NS
5	Solomon RM, 2022 LMICs	SCI	Systematic Review	5	All telemedicine modalities were included: store-and-forward, remote monitoring and interactive services. All forms of telecommunication methods were included (i.e., telephone, Internet, video and audio conferencing).	NS	Synchronous	NS	NS	Patients

6	Parmar ST, 2021, India and Canada	Stroke and Cerebral palsy (CP)	Mixed RCT	10 stroke, 6 CP	The telerehabilitation trials utilized the Game-based Telerehabilitation Platform (GTP), including the Inertial-Based (IB) mouse and computer games.	Clinical with transition to home	NS	PT	Stroke Patients Trial: Four therapy sessions in a clinical setting, followed by a 16-week home program (four times per week). Children with Cerebral Palsy Trial: Four 45-minute therapy sessions in a clinical setting, followed by a 12-week home program (four times per week for 30 minutes).	Both
7	Sari YM, 2023 Indonesia	Dementia	Pilot interventional study	30 patients 30 carers	Zoom video call	Home program	Synchronous	PT	12 weeks. The four online (visit) sessions were scheduled at weeks 1, 2, 6 and 10 during the 12-week intervention phase	Both

8	SN Suhaidah, 2022 Southeast Asia	Stroke	Scoping review	1,470	Video-based therapy, a smartphone with ECG-recording, and videoconferencing with tele-therapists.	Hospital(32 studies) Community(9 studies)	Asynchro nous	PT	6, 30min self-sessions for 2 weeks and indicate their completion after each session in a private group chat.	Both
9	Leochico CFD, 2023 Philipines	Stroke	Pilot interventio nal study	19	Facebook and YouTube	Home program	Synchron ous	NS	30 minutes every other weekday for a total of 6 sessions	Patients
10	Raju Dhakal, 2022 Nepal	SCI and ABI	Feasibility study	97	Specialised audio-visual system installed in the MDT room at the facility. Smart LED screen People link UVC (conference call speaker) People link Quordo (conference phone) People i-Com WHD camera (web camera) Mobile phones - Facebook, messenger, whatsapp and viber	Rehabilitaion Centre	Synchron ous	PT	Consultations - 1-2 times (Week 1) Follow up - 4th week	Patients
11	Barretto, 2023 LMICs	Parkinsons	Non-Systematic Review of Literature	15 Patients 12 Caregive rs	Care model and manual to tele-rehabilitation program	Home Program	Asynchro nous	PT, OT	Unique 16-session multi-disciplinary community rehabilitation module	Both

12	E Nizeyimana, 2022 LMICs	NS	Scoping review	29 studies	Online calling platforms: It mentions platforms like Skype, WhatsApp, Google Meet, Facebook Messenger, Viber, and FaceTime Remote monitoring with sensors/cameras: It indicates the use of videoconferencing for real-time interactions between patients and healthcare professionals. Asynchronous methods using emails, text messages, and short videos or images exchanged via mobile devices to facilitate TR services.	Rehabilitaion Centre, hospitals, home based	Both	PT, OT, SLT	Approx 2-5 times a week 8-24 weeks	Both
13	J. Jaime Miranda, 2017 Peru	Stroke	Case Study	NS	mHealth Technology	NS	NS	NS	NS	NS
14	N Tyagi, 2019 India	SCI and Stroke	Case Series	2	A combination of telephone calls live video chat, and WhatsApp.	Home based	Both	PT,OT	8 weeks	Both
15	FS. Sarfo, 2018 Ghana	Stroke	A Prospective, single arm, pilot study design	20	Smartphone with the 9zest Stroke App®	Home based	Asynchronous	PT	30-60 min/12 weeks	Patients
16	C Froilan, 2020 Philippines	Paraplegia: Spinal cord injury	Case report	2	Android smartphone Social Media App - Viber	Home based	Both	PT,OT	approx 30 min Telerehab call	Patients

17	Marlina, 2023 Indonesia	Stroke	Non-randomised control trial	70	SIMTROKE app on an android device	Home based	Asynchronous	PT	NS	Both
18	D Garg, 2021 India	Parkinsons	Single-center, prospective cohort study	22	Smartphone - Video Logs	Rehabilitation centre and Home Based	Asynchronous	PT	1 session per week x 4 weeks 1 session every 2 weeks x 8 weeks	Both

SCI - Spinal Cord Injury, CP - Cerebral Palsy, ABI – Acquired Brain Injury , PT - Physiotherapy, OT - Occupational Therapy, RCT - Randomised Control Trial, SLT - Speech & Language Therapist, NS - Not Specified, LMIC – Low and Middle Income Countries, MDT – Multi-disciplinary

Table 2_JBI critical appraisal tools_scores

Click here to access/download;Table;Revised Table 2_JBI criticial appraisal scores.docx

Study design	Study ID	Author & Year	INTERNAL VALIDITY BIAS RELATED TO:											STATISTICAL CONCLUSION VALIDITY		
			DOMAIN	Selection and allocation			Administration of intervention/exposure			Assessment, detection, and measurement of the outcome			Participant retention			
			Question No.	1	2	3	4	5	6	7	8	9	10	11	12	13
RCT	1	Yan LL et al, 2021		yes	no	unclear	no	no	yes	yes	yes	yes	yes	yes	yes	yes
	6	Parmar S 2021		yes	unclear	unclear	unclear	unclear	unclear	no	unclear	no	yes	yes	yes	yes
	7	Sari YM, 2023		no	no	yes	no	no	yes	no	yes	yes	no	yes	yes	yes
	9	Leochicho CFD 2023		no	no	yes	no	no	yes	no	yes	yes	no	no	yes	yes
			Clearly and explicitly stated question	Appropriate inclusion criteria	Appropriate Search strategy	Adequate sources of search	Appropriate criteria for study appraisal	Critical appraisal by two or more independent reviewers	Methods to minimize errors in data extraction	Methods used to combine studies appropriate	Assessment of likelihood of publication bias	Recommendations for policy and/or practice supported by the reported data	Appropriate specific directives for new research			

Review & Research synthesis	2	MN Babur, 2022	no	unclear	unclear	unclear	unclear	unclear	unclear	unclear	no	yes	yes			
	3	Shalash A, 2021	no	no	unclear	unclear	no	unclear	no	unclear	unclear	yes	yes			
	4	Ganpathy K. 2020	yes	unclear	unclear	unclear	no	unclear	no	unclear	unclear	yes	yes			
	5	Solomon RM 2022	yes	yes	yes	yes	yes	yes	unclear	unclear	yes	yes	yes			
	8	SN Suhaidah, 2022 2022 South east Asia	yes	yes	yes	yes	no	no	unclear	unclear	yes	yes	yes			
	11	Barretto M, 2023	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			
	12	Nizeyimana E 2022	YES	YES	YES	YES	UNCLEAR	NO	NO	N/A	NO	UNCLEAR	NO			

			Clear description of patient's demographic characteristics	Clear description and timeline of patient's history	Clear description current clinical condition of the patient on presentation	Clear description of diagnostic tests or assessment methods and its results	Clear description of intervention(s) or treatment procedure(s)	Clear description of the post-intervention clinical condition	Identification and description of adverse events (harms) or unanticipated events	Does the case report provide takeaway lessons						
Case report	16	Leochico CFD 2020	YES	YES	YES	NO	YES	YES	NO	YES						
	13	Miranda JJ, 2017	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						
Cohort			Were the two groups similar and recruited from the same population?	Were the exposures measured similarly to assign people to both expos	Was the exposure measured in a valid and reliable way?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	Were the outcomes measured in a valid and reliable way?	Was the follow up time reported and sufficient to be long enoug	Was follow up complete, and if not, were the reasons to loss to follow up	Were strategies to address incomplete follow up utilized?	Was appropriate statistical analysis used?			

				ed and unexposed groups?						h for outcomes to occur?	described and explored?					
	10	Dhakal R, 2022	N/A	N/A	YES	N/A	N/A	YES	YES	UNCLEAR	YES	N/A	UNCLEAR			
	15	Sarfo FS, 2018	N/A	N/A	UNCLEAR	UNCLEAR	N/A	YES	YES	YES	YES	N/A	YES			
	18	Garg D 2021	N/A	N/A	N/A	UNLEAR	N/A	UNCLEAR	YES	YES	YES	N/A	YES			

Case series			Were there clear criteria for inclusion in the case series?	Was the condition measured in a standard, reliable way for all participants included in the case series?	Were valid methods used for identification of the condition for all participants included in the case series?	Did the case series have consecutive inclusion of participants?	. Did the case series have complete inclusion of participants?	Was there clear reporting of the demographics of the participants in the study?	. Was there clear reporting of clinical information of the participants?	. Were the outcomes or follow-up results of cases clearly reported?	. Was there clear reporting of the presenting sites'/clinics' demographic information?	Was statistical analysis appropriate?				
	14	Tyagi N 2019	UNCLEAR	YES	UNCLEAR	NO	UNCLEAR	YES	YES	YES	NO	N/A				

Quasi-experimental			Is it clear in the study what is the “cause” and what is the “effect” (ie, there is no confusion about which variable comes first)?	Was there a control group?	Were participants included in any comparisons similar?	Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Were there multiple measurements of the outcome, both pre and post the intervention/ exposure?	Were the outcomes of participants included in any comparisons measured in the same way?	Were outcomes measured in a reliable way?	Was follow-up complete and, if not, were differences between groups in terms of their follow-up adequately described and analyzed?	Was appropriate statistical analysis used?					
	17	Marlina M, 2023	YES	YES	UNCLEAR	UNCLEAR	YES	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	N/A				

Figure-1 PRISMA flowchart

Click here to access/download;Figure;Fig 1PRISMA.docx

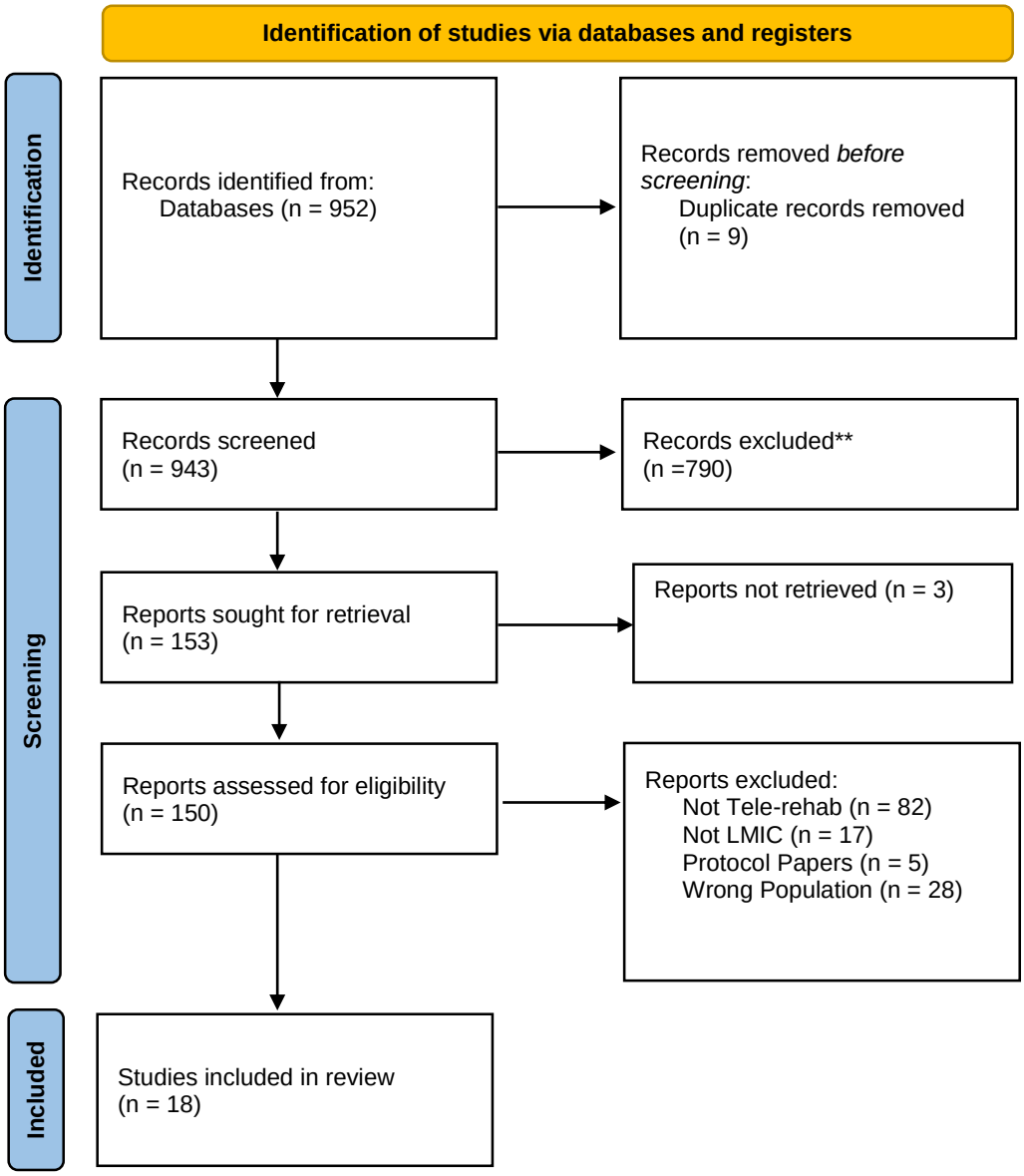
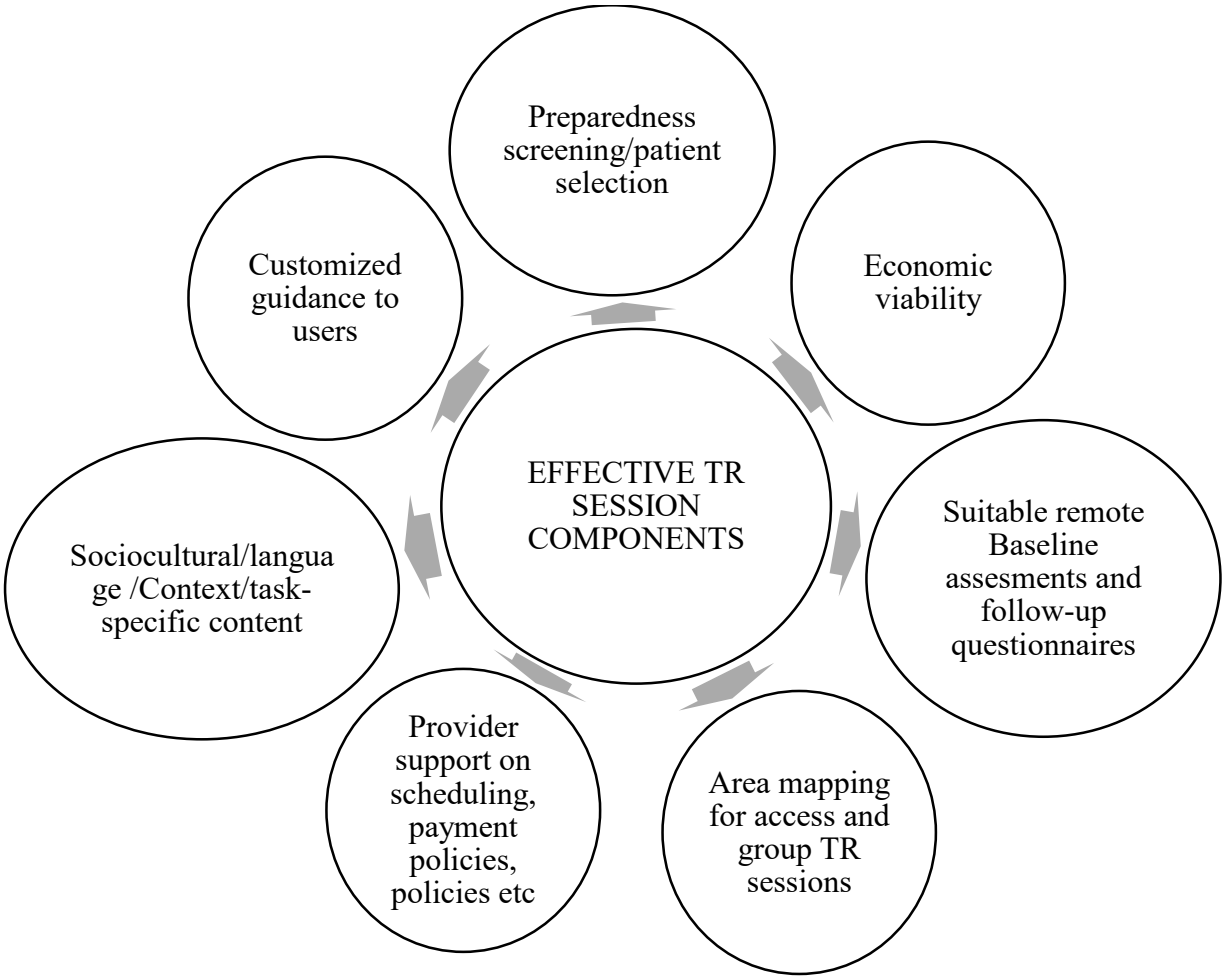


Figure 2: Requirements for an effective TR session



Key words:

Population	Intervention	AND intervention (https://www.frontiersin.org/files/Articles/904855/fpubh-10-904855-HTML/image_m/fpubh-10-904855-g009.jpg)	AND intervention	Place
Cerebrovascular disease	Neuro rehabilitation	Telerehabilitation	Education	Low and middle income countries
Neurological injuries	Rehabilitation	telehealth	Training	Angola
Neuroinfections	Neurological Rehabilitation	telemedicine	Curriculum	Algeria
Neurological disorders	Occupational therapy/	mHealth	Workshop	Bangladesh
Neurological diseases	Rehabilitation or rehab	Zoom	Competency	Benin
Cerebellar dysfunctions	In-patient rehabilitation	SMS	Skills	Bhutan
Parkinson's disease	Outpatient rehabilitation	Whatsapp	Resources	Bolivia
Multiple sclerosis	Community based rehabilitation	Phonecalls	Infrastructure	Cabo Verde
Cauda Equina syndrome	Multidisciplinary rehabilitation	telephone	Practice	Cambodia
Ataxia	Interdisciplinary rehabilitation	Call	Delivery	Cameroon
Guillian Barre Syndrome	Early rehabilitation	Remote monitoring	Syllabus	Comoros
Meningitis	Intensive rehabilitation	Digital	Websites	Congo, Rep.
Chronic inflammatory Demyelinating polyneuropathy	Physical rehabilitation	Synchronous telerehabilitation	Research	Côte d'Ivoire
Traumatic brain injuries	Speech therapy	Asynchronous telerehabilitation		Djibouti

Spinal cord injuries	Language therapy	Smart phone applications		Egypt, Arab Rep.
Motor neuron disease	Activities of daily living	sensors		El Salvador
Transverse myelitis	Physical activity	virtual reality		Eswatini
Cerebellar disorders	Rehabilitation, vocational	game based rehabilitation		Ghana
	Exercise therapy	m-health		Haiti
	Movement therapy	e-health		Honduras
	Muscle strengthening	M-health		India
	Physical conditioning	mobile-health		Indonesia
		web-app		Iran, Islamic Rep
		Website		Kenya
		mobile applications		Kiribati
		technology		Kyrgyz Republic
				Lao PDR
				Lebanon
				Lesotho
				Mauritania
				Micronesia, Fed. Sts
				Mongolia
				Morocco
				Myanmar
				Nepal
				Nicaragua
				Nigeria
				Pakistan
				Papua New Guinea
				Philippines
				Philippines
				Samoa
				São Tomé and Principe
				Senegal
				Solomon Islands
				Sri Lanka
				Tanzania

				Tajikistan
				Timor-Leste
				Tunisia
				Ukraine
				Uzbekistan
				Vanuatu
				Vietnam
				West Bank and Gaza
				Zimbabwe
				Afghanistan
				Burkina Faso
				Central African Republic
				Chad
				Congo, Dem. Rep
				Eritrea
				Ethiopia
				Gambia, The
				Guinea
				Guinea-Bissau
				Korea, Dem. People's Rep
				Korea, Dem. People's Rep
				Korea, Dem. People's Rep
				Liberia
				Madagascar
				Malawi
				Mali
				Mozambique
				Niger
				Rwanda
				Sierra Leone
				Somalia
				South Sudan and Sudan
				Syrian Arab Republic
				Togo
				Uganda
				Yemen, Rep.
				Zambia

Search Strategy

Cerebrovascular disease OR Neurological injuries OR Neuroinfections OR Neurological disorders OR Neurological diseases OR Cerebellar dysfunctions OR Parkinsons disease OR Multiple sclerosis OR Cauda Equina syndrome OR Ataxia OR Guillian Barre Syndrome OR Meningitis OR Chronic inflammatory OR Demyelinating polyneuropathy OR Traumatic brain injuries OR Spinal cord injuries OR Motor neuron disease OR Transverse myelitis OR Cerebellar disorders AND

Neuro rehabilitation OR Rehabilitation OR Neurological Rehabilitation OR Occupational therapy OR Rehabilitation OR rehab OR In-patient rehabilitation OR Outpatient rehabilitation OR Community based rehabilitation OR Multidisciplinary rehabilitation OR Interdisciplinary rehabilitation OR Early rehabilitation OR Intensive rehabilitation OR Physical rehabilitation OR Speech therapy OR Language therapy OR Activities of daily living OR Physical activity OR vocational rehabilitation OR Exercise therapy OR Movement therapy OR Muscle strengthening OR Physical conditioning AND

Telerehabilitation OR telehealth OR telemedicine OR mHealth OR Zoom OR SMS OR Whatsapp OR Phonecalls OR telephone OR Call OR Remote monitoring OR Digital OR Synchronous telerehabilitation OR Asynchronous telerehabilitation OR Smart phone OR applications OR sensors OR virtual reality OR game based rehabilitation OR m-health OR e-health OR M-health OR mobile-health OR web-app OR Website OR mobile applications OR technology AND

Angola OR Algeria OR Bangladesh OR Benin OR Bhutan OR Bolivia OR Cabo Verde OR Cambodia OR Cameroon OR Comoros OR Congo Rep OR Cote dIvoire OR Djibouti OR Egypt OR Arab Rep OR El Salvador OR Eswatini OR Ghana OR Haiti OR Honduras OR India OR Indonesia OR Iran Islamic Rep OR Kenya OR Kiribati OR Kyrgyz Republic OR Lao PDR OR Lebanon OR Lesotho OR Mauritania OR Micronesia Fed Sts OR Mongolia OR Morocco OR Myanmar OR Nepal OR Nicaragua OR Nigeria OR Pakistan OR Papua New Guinea OR Philippines OR Samoa OR Sao Tome and Principe OR Senegal OR Solomon Islands OR Sri Lanka OR Tanzania OR Tajikistan OR Timor-Leste OR Tunisia OR Ukraine OR Uzbekistan OR Vanuatu OR Vietnam OR West Bank Gaza OR Zimbabwe OR Afghanistan OR Burkina Faso OR Burundi OR Central African Republic OR Chad OR Congo, Dem. Rep OR Eritrea OR Ethiopia OR Gambia Guinea OR Guinea Bissau OR Korea Dem Peoples Rep OR Liberia OR Madagascar OR Malawi OR Mali OR Mozambique OR Niger OR Rwanda OR Sierra Leone OR Somalia OR South Sudan OR Syrian Arab Republic OR Togo OR Uganda OR Yemen OR Rep. Zambia OR LMIC OR low and middle income countries

TNR examples and toolkits from HICs

Various examples from HICs also exist. Via the 'Managing Epilepsy Well' network, programs to improve quality of Life of those with epilepsy have been delivered successfully.[1] Such TR programs are beneficial especially due to their features of community engagement, cultural, linguistic, literacy considerations and collaboration with relevant local affiliates. Szturm T etal implemented a 16-week home-based TR regime among those with a stroke that included telephonic discussion with participants once a week for feedback, guidance on progression to more difficult exercises as needed and periodic in-person follow-up session.[2] Finally, the need of structured training for effective TR implementation is further emphasized with training aspects to include knowledge and skills to utilize TR, ensuring ideal setup and establishing required competencies for TR among providers and users.[3] Afshari et al describes the feasible and effective mode of teleneurology curriculum in a formal didactic mode.[4] A model for teleneurology curriculum with relevant evaluation tools is given by the American Academy of Neurology Telemedicine Work Group.[5] There are numerous examples of web-based platforms being used for tele-education of health providers. One such example is the 'Virtual Professor Program' by the International Parkinson and Movement Disorder Society. However, clinical aspects of conditions rather than TR-implementation were of part of the program.[6] UK is implementing the N-ROL program for those with acquired brain injuries that is a comprehensive TNR program that selects participants on a preset criteria for PT, OT and SLP regimes.[7]

Panel 1: TR related toolkits from HICs

1. Canadian Best Practice guidelines- Provides indicators for monitoring TR session, telestroke planning questionnaire, and proposed competencies
2. Melbourne Disability Institution, Said C et al, : Shared decision making tree and risk assessment guide
3. Auckland University of technology: Guide for screening and recording of TR

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