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Systematic review of guidelines to identify recommendations for upper limb robotic rehabilitation after stroke

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Abstract

INTRODUCTION:

Upper limb motor impairment is one of the most frequent stroke consequences. Robot therapy may represent a valid option for upper limb stroke rehabilitation, but there are still gaps between research evidences and their use in clinical practice. The aim of this study was to determine the quality, scope, and consistency of guidelines clinical practice recommendations for upper limb robotic rehabilitation in stroke populations.

EVIDENCE ACQUISITION:

We searched for guideline recommendations on stroke published between January 1st, 2010 and January 1st, 2020. Only the most recent guidelines for writing group were selected. Electronic databases (n=4), guideline repertories and professional rehabilitation networks (n=12) were searched. We systematically reviewed and assessed guidelines containing recommendation statements about upper limb robotic rehabilitation for adults with stroke. PROSPERO registration number: CRD42020173386

EVIDENCE SYNTHESIS:

Four independent reviewers used the Appraisal of Guidelines for Research and Evaluation (AGREE) II instrument, and textual syntheses were used to appraise and compare recommendations. From 1324 papers screened, eight eligible guidelines were identified from six different regions/countries. Half of the included guidelines focused on stroke management, the other half on stroke rehabilitation. Rehabilitation assisted by robotic devices is generally recommended to improve upper limb motor function and strength.

The exact characteristics of patients who could benefit from this treatment as well as the correct timing to use it are not known.

CONCLUSIONS:

This systematic review has identified many opportunities to modernize and otherwise improve stroke patients' upper limb robotic therapy. Rehabilitation assisted by robot or electromechanical devices for stroke needs to be improved in clinical practice guidelines in particular in terms of applicability.

Key words: rehabilitation, robot, upper limb, stroke, guidelines, electromechanical devices

Introduction

Stroke represents a leading cause of disability and the second cause of death worldwide.[1] Its global burden is growing due to higher incidence rate resulting in a lower mortality rate.[2] Upper limb motor impairment is one of the most frequent stroke consequence.[3] Rehabilitation plays a key role in reducing motor impairment and disability.[4] There is a large variety of therapeutic options for stroke rehabilitation, but the effectiveness of these strategies on motor functions is still debated.[5] Literature evidence shows that repetitive and task-oriented exercises are effective in improving upper limb functions.[6] Robots can support this kind of training, providing highly repetitive therapy over a longer period and, therefore, they are often integrated in clinical practice for stroke patients.[7] More than 120 devices for robotic therapy of the upper limb have been developed and used in neurorehabilitation.[8] Moreover, robots can help understanding individual needs (furnishing quantitative measures of impairment) and optimising learning strategies, by adapting rehabilitation “as needed”.[9] However, there are still gaps between research evidences and their use in clinical practice.[10]

Guidelines allow clinicians to use the evidence in an easier way, supporting effective interventions, while advising against the ones not based on evidence.[11] However, many countries have their own guidelines, with different content and scope, level of evidence and detail, more or less updated, making it difficult to implement them in the clinical practice.[12]

The Appraisal of Guidelines for Research and Evaluation II (AGREE II) is a reliable tool used to assesses the quality of guidelines, which developed to address the issue of variability in guideline quality.[13] It has been widely used for different guidelines in recent years in rehabilitation. [14-16]

Therefore, the aim of the present research was to examine the methodological quality and the agreement of stroke guidelines dealing with upper limb robot rehabilitation by mean the AGREE II instrument; and identify gaps limiting evidence-based practice and highlight potential areas for improvement.

Evidence acquisition

Guideline Search

We followed the Equator Network reporting recommendations outlined in the Appraisal of Guidelines, Research and Evaluation (AGREE) II instrument16 and the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement.[17] Our systematic search used popular search databases, guidelines repertories, and professional rehabilitation networks in line with SPIDER tool strategy18 (Table I). PubMed, ISI Web of Knowledge, EMBASE and SciELO Citation Index databases were searched independently and synchronously by 2 authors on June 1st, 2020 (AM, AP). Guideline repositories included Australian National Health and Medical Research Council clinical practice guidelines, Canadian Medical Association Infobase of Clinical Practice Guidelines, National Library for Health Guidelines Database (UK), US National Guideline Clearinghouse, Guidelines International Network, New Zealand Guidelines Group, eGuidelines, NICE, Scottish Intercollegiate Guidelines Network (SIGN), Guidelines International Network, National Guideline Clearinghouse, National Collaborating Centre for Chronic Conditions. Search terms included words related to brain stroke, rehabilitation, guidelines, robotic therapy, and upper limb. The search strategy is available in the Supplementary Digital Material.

Table I.— *SPIDER tool search strategy*

S	PI	D	E	R
Sample	**Phenomenon of Interest**	**Design**	**Evaluation**	**Research Type**
Stroke patients	Robotic	Guidelines	Grade of	Qualitative

	rehabilitation for upper limb motor recovery		Recommendation, Levels of Evidence	
"stroke" [MeSH Terms] OR "cerebral stroke" [MeSH Terms] OR "cerebral strokes" [MeSH Terms]	"Rehabilitation" [MeSH Terms]	"Practice Guideline" OR "Guideline" OR "Consensus Development Conference"	"Recommendation"	

Guideline Inclusion Criteria

We included all guideline recommendations for upper limb robotic rehabilitation in adults with stroke published between January 1st, 2010 and January 1st, 2020. A guideline was considered as a set of the latest recommendations based on evidence appraisal and consensus from a single writing group, even if such recommendations were published separately. Only English written guidelines were considered for eligibility. Our search was focused on guidelines referring to stroke rehabilitation and, in particular, considering the use of robots for upper limb rehabilitation.

Guideline Analysis

Titles and abstracts were screened (AM) and full-text papers reviewed independently by two reviewers (AM, AP) using predetermined criteria, as in the previous paragraph. In case of disagreement, an independent reviewer (GM) stepped in. Reviewers identified information, treatment recommendations and their level of evidence/grade of recommendations (when available). Moreover, each guideline was checked for the year, edition, country, national/international recommendations contained. Textual descriptive synthesis of recommendations was used to analyses the scope, context and consistency of the founded guidelines. Then, the AGREE-II instrument16 was used to appraise the methodological quality of the included guidelines across six domains: scope and purpose, stakeholder involvement, rigor of development, clarity and presentation, applicability and editorial independence. It uses a 7-point agreement scale from 1 (strongly disagree) to 7 (strongly agree) for 23 items. Each guideline was independently rated by four raters (two physicians specialized in physical and rehabilitation medicine, a physiotherapist and an occupational therapist), working in the field of neurological rehabilitation also assisted by technological devices and robot. Domain scores are calculated by summing up all the scores of the individual items and by scaling the total as a percentage of the maximum possible score for that domain as follow:

$$\frac{Obtained\ score - Minimum\ possible\ score}{Maximum\ possible\ score - Minimum\ possible\ score} * 100$$

When Minimum/Maximal possible score is calculated respectively:

$$strongly\ disagree/strongly\ agree\ x\ N\ (items)\ x\ N\ (appraisers)$$

As suggested by the AGREE II19, we decided to prioritize two domains (Applicability and Overall) taking into account a quality threshold (>70%) for those domains.

Finally, recommendations from the guidelines were synthesized to provide a unified version.

Evidence synthesis

We found 1324 records through the research method. The flow diagram in Figure 1 shows our search results. After screening title and abstract, 1157 were excluded because they do not meet the research purpose. Then, 159 full text papers were assessed for eligibility. Finally, eight guidelines matched the inclusion criteria.

Figure 1.— *flow diagram of the search results, adapted from PRISMA*[14]

The detailed information about the eight guidelines which meet (or satisfy) the inclusion criteria are available in Table II. They cover six different nations all over the world. Three out of the eight guidelines do not report the funding. Moreover, half of the included guidelines focused on stroke management, the other half on stroke rehabilitation.

Table II.— *Characteristics of included clinical practice guidelines*

Development Organization	Year	Edition	Country	Funding	Focus
Scottish Intercollegiate Guidelines Network[20]	2010	2	Scotland	NR	SR
Stroke Foundation of New Zealand[21]	2010	1	New Zealand	R	SM
Royal Dutch Society for Physical Therapy[22]	2014	2	Nederland	NR	SR
Canadian Heart and Stroke Foundation[23]	2015	5	Canada	R	SR
Royal College of Physicians[24]	2016	5	United Kingdom	R	SM
American Heart Association/American Stroke Association[25]	2016	2	United States of America	R	SR
Stroke Foundation[26]	2017	5	Australia	R	SM
Department of Veterans Affairs, Department of Defense[27]	2019	4	United States of America	NR	SM

(NR: not reported; R: reported; SM: stroke management; SR: stroke rehabilitation)

Table III summarizes the findings about the use of upper limb robotic rehabilitation after stroke.

Table III.— *Summary of findings*

Development Organization	Findings	Grading system	Level of evidence/Grade of recommendation
Scottish Intercollegiate Guidelines Network[20]	- Electromechanical/robotic devices may be considered to improve arm motor function and motor strength in selected patients where the necessary equipment is already available and healthcare professionals are competent in the use of the equipment.	SIGN system	Level A Level A

	- Insufficient evidence of robot-mediated passive therapy for post-stroke spasticity.		
Stroke Foundation of New Zealand[21]	- Mechanical assisted training should be given in order to encourage using upper limb as much as possible.	Guidelines International Network (G-I-N) and SIGN systems	Grade B
Royal Dutch Society for Physical Therapy[22]	- Unilateral robot-assisted training of the paretic arm for shoulder and elbow training of patients with a stroke improves the selective movements and muscle strength and reduces atypical pain. Bilateral robot-assisted training of the elbow and wrist improves the selective movements and muscle strength of the arm of patients with a stroke in early and chronic phase. The guideline development team recommends using shoulder-elbow and/or elbow-wrist robotics for patients with a stroke as an add-on to exercise therapy if one or more goals at the body function level have been defined.	Self-making system	Level 1

Canadian Heart and Stroke Foundation[23]	- Virtual reality, including robotic interfaces, can be used as adjunct tools to other rehabilitation therapies to provide additional opportunities for engagement, feedback, repetition, intensity and task-oriented training.	Self-making system	Early-Level A; Late-Level A
Royal College of Physicians[24]	- Robot-assisted movement therapy as an adjunct to conventional therapy in people with reduced arm function after stroke in the context of a clinical trial.	Not applicable	Not available
American Heart Association/American Stroke Association[25]	- Robot-assisted movement training to improve motor function and mobility after stroke in combination with conventional therapy may be considered; Robotic therapy is reasonable to consider to deliver more intensive practice for individual with moderate to severe upper limb paresis	AHA concerning classes and levels of evidence	Class IIa Level A
Stroke Foundation[26]	- For stroke survivors with mild to severe arm weakness, mechanically assisted arm training (e.g. robotics) may be used to improve upper limb function.	Not applicable	Not available
Department of Veterans Affairs, Department of Defense[27]	- Recommend robot-assisted movement therapy as an adjunct to	Self-making system	Weak for

	conventional therapy in patients with deficits in arm function to improves motor skill at the joints trained		

Rehabilitation assisted by robotic devices is generally recommended to improve upper limb motor function and strength4. The exact characteristics of patients who could benefit from this treatment as well as the correct timing to use it are not known. Two guidelines suggest using robotic therapy in moderate to severe upper limb paresis[25] or mild to severe arm weakness[26]. Only one guideline[22] clarifies the disease phase for recommendations. Table IV and Figure 2 show the assessed methodological quality of the included guidelines across six domains: scope and purpose, stakeholder involvement, rigor of development, clarity and presentation, applicability and editorial independence.

Table IV.— *AGREE-II scores for each domain (Dom.) and general evaluation*

Development Organization	**Domain 1**	**Domain 2**	**Domain 3**	**Domain 4**	**Domain 5**	**Domain 6**	**General Evaluation**
	Scope and Purpose	**Stakeholder Involvement**	**Rigor of Development**	**Clarity of Presentation**	**Applicability**	**Editorial Independence**	
Scottish Intercollegiate Guidelines Network[20]	84,72	90,28	82,14	83,33	75,00	62,50	70,83
Stroke Foundation of New Zealand[21]	81,94	83,33	91,07	76,39	71,88	64,58	75,00
Royal Dutch Society for Physical Therapy[22]	86,11	84,72	90,48	91,67	61,46	75,00	83,33
Canadian Heart and Stroke Foundation[23]	80,56	70,83	64,88	80,56	53,13	75,00	66,67
Royal College of Physicians[24]	83,33	77,78	95,24	88,89	65,63	83,33	87,50
American Heart Association/American Stroke Association[25]	58,33	44,44	64,88	77,78	53,13	62,50	62,50
Stroke Foundation[26]	93,06	88,89	92,86	90,28	71,88	91,67	91,67
Department of Veterans Affairs, Department of Defense[27]	86,11	77,78	91,07	83,33	54,17	85,42	83,33

Figure 2.— *Bar plot of the general evaluation and applicability of the AGREE-II scores*

The main goal of a medical guideline is to provide an evidence-based and easily accessible tool to guide clinicians in choosing the treatment strategy, summarizing the known literature. To our knowledge, this is the first systematic review of all clinical practice guidelines of robotic treatment for upper limb rehabilitation after stroke. The quality assessment was undertaken using the AGREE II as an instrument to screen the quality of CPGs development, methodology and reporting. Despite the decades of literature evidence on robotics, we have found only eight guidelines published from 2010 to 2020.[20-27] Six guidelines received the highest rating (or scores) for general evaluation rating: Scottish Intercollegiate Guidelines Network[20], Stroke Foundation of New Zealand[21], Royal Dutch Society for Physical Therapy[22], Royal College of Physicians[24], Stroke Foundation[25], Department of Veterans Affairs, Department of Defense[27]. Furthermore, only four guidelines received a high reviewers rating for applicability: Scottish Intercollegiate Guidelines Network[20], Stroke Foundation of New Zealand[21], Stroke Foundation[22]. The quality of guidelines was heterogeneous and the domains that generally scored poorly were "applicability" in particular the facilitators and barriers to its application were poorly described across guidelines in accordance with a review of stroke guidelines on aphasia rehabilitation.[14] Another factor reducing applicability could be the fact that only four guidelines[20,22,23,25] have been developed specifically for stroke rehabilitation while many are dedicated to all stroke management, resulting in little space given to robotic rehabilitation.

The highest rated domain was "rigor of development" and "clarity of presentation". Most guidelines described the criteria for selecting the evidence, the methods for formulating the recommendations and the key recommendations are easily identifiable.

Our systematic review has identified many opportunities to modernize and otherwise improve stroke patients' upper limb robotic therapy. We have to underline that the selected patient subgroup that could benefit from robotic devices is not clarified throughout the guidelines. Moreover, the optimal time window and frequency are not clarified. Guidelines often do not specify the type of recommended robotic device (end effector/exoskeleton) and its specificity for proximal or distal upper limb use. Although, practice guidelines were consistent in suggesting the use of robotic devices as an add on to conventional therapies to encourage arm use, it is the still not established and recommended when and how and for whom a specific device could be used. In add, stroke guidelines as well as other neurological guidelines provide very little specific guidance on assessment of the upper limb, even within ICF domains and/or pathology-specific recommendations.[28]

Furthermore, an agreement regarding the objective and the outcome measure in general for rehabilitation robotic measure is needed and possible at the light of the recent effort and advancement in the field. Finally, the optimal dose (number of repetition and time of therapy), frequency and duration of the robotic rehabilitation treatment is not taken into account in the current available guidelines even at the light that robot might easy measure these parameters. The above reported limits of the analyzed guidelines are probably due to the methodological heterogeneity in terms of type of robots, frequency and dose of treatment used in the most of the studies published so far in this field. Furthermore, patients in different stages of disease were often treated and only in the recent studies on large samples they are stratified for latency from the event. Note that the patients included in the studies on upper limb robotic rehabilitation after stroke are not often characterized in terms of cognitive impairment as well as motor proximal and/or distal impairment. Further studies on homogeneous and large sample of patients using a motor and cognitive evaluation as well as an instrumental robotic measures, could be useful to produce more detailed guidelines on this important topic.

Our review has some limitations: i) study only included English language guidelines.; ii) AGREE II instrument did not involve the judgment of the recommendation opinions decided with a high variability among guidelines.

Conclusions

Despite the increasing evidence of robotics effectiveness on upper limb strength and motor function, guidelines needs to be improved, especially in the fields of applicability and in particular should clarify the selected patient subgroup that could benefit from robotic devices as well as the optimal time window and dose of this treatment. Future research should focus on the robotic treatment measures among a general specific guidance on assessment of the upper limb measures.

REFERENCES

1. Di Carlo A. Human and economic burden of stroke. Age Ageing 2009;38:4–5.
2. Katan M, Luft A. Global Burden of Stroke. Semin Neurol. 2018;38:208-211.
3. Raghavan P. Upper Limb Motor Impairment After Stroke. Phys Med Rehabil Clin N Am. 2015;26:599-610.
4. Mehrholz J, Pohl M, Platz T, Kugler J, Elsner B. Electromechanical and robot-assisted arm training for improving activities of daily living, arm function, and arm muscle strength after stroke. Cochrane Database Syst Rev 2018,9.CD006876.
5. Veerbeek JM, van Wegen E, van Peppen R, van der Wees PJ, Hendriks E, Rietberg M, et al. What is the evidence for physical therapy poststroke? A systematic review and meta-analysis. PloS One 2014;9:e87987.
6. French B, Thomas LH, Coupe J, McMahon NE, Connell L, Harrison J, et al. Repetitive task training for improving functional ability after stroke. Cochrane Database Syst Rev. 2016;11:CD006073.

7. Klamroth-Marganska V. Stroke Rehabilitation: Therapy Robots and Assistive Devices. Adv Exp Med Biol. 2018;1065:579-587.

8. Maciejasz P, Eschweiler J, Gerlach-Hahn K, Jansen-Troy A, Leonhardt, S. A survey on robotic devices for upper limb rehabilitation. J Neuroeng Rehabil 2014;11:3.

9. Squeri V, Basteris A, Sanguineti V. Adaptive regulation of assistance 'as needed' in robot-assisted motor skill learning and neuro-rehabilitation. IEEE Int Conf Rehabil Robot. 2011;2011:5975375.

10. Bayley MT, Hurdowar A, Richards CL, Korner-Bitensky N, Wood-Dauphinee S, Eng JJ, et al. Barriers to implementation of stroke rehabilitation evidence: findings from a multi-site pilot project. Disabil Rehabil. 2012;34:1633-8.

11. Woolf SH, Grol R, Hutchinson A, Eccles M, Grimshaw J. Clinical guidelines: potential benefits, limitations, and harms of clinical guidelines. BMJ. 1999;318:527-30.

12. Hurdowar A, Graham ID, Bayley M, Harrison M, Wood-Dauphinee S, Bhogal S. Quality of stroke rehabilitation clinical practice guidelines. J Eval Clin Pract. 2007;13:657-64.

13. Brouwers MC, Kho ME, Browman GP, Burgers JS, Cluzeau F, Feder G, et al. AGREE Next Steps Consortium. AGREE II: advancing guideline development, reporting and evaluation in health care. CMAJ. 2010;182:E839-42.

14. Wang Y, Li H, Wei H, Xu X, Jin P, Wang Z, et al. Assessment of the quality and content of clinical practice guidelines for post-stroke rehabilitation of aphasia. Medicine (Baltimore). 2019;98:e16629.

15. Jolliffe L, Lannin NA, Cadilhac DA, Hoffmann T. Systematic review of clinical practice guidelines to identify recommendations for rehabilitation after stroke and other acquired brain injuries. BMJ Open. 2018;8:e018791.

16. Dijkers MP, Ward I, Annaswamy T, Dedrick D, Feldpausch J, Moul A, Hoffecker L. Quality of Rehabilitation Clinical Practice Guidelines: An Overview Study of AGREE II Appraisals. Arch Phys Med Rehabil. 2020;101:1643-1655.

17. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ. 2009;339:b2535.

18. Cooke A, Smith D, Booth A. Beyond PICO: the SPIDER tool for qualitative evidence synthesis. Qual Health Res. 2012;22:1435-43.

19. The Appraisal of Guidelines for Research & Evaluation Instrument (AGREE II) FAQ. Available from: https://www.agreetrust.org/resource-centre/agree-ii/faq-agree-ii-2/ [cited 2020, Sep 22].

20. Veerbeek JM, van Wegen EEH, & van Peppen RPS. KNGF clinical practice guideline for physical therapy in patients with stroke: Royal Dutch Society for physical therapy. The Netherlands. 2014. Available from: https://www.dsnr.nl/wp-content/uploads/2012/03/stroke_practice_guidelines_2014.pdf [cited 2020, Sep 22].

21. Smith, L. (2010). Management of patients with stroke: Rehabilitation, prevention and management of complications, and discharge planning: A national clinical guideline (Vol. 118). SIGN. 2010. Available from: https://www.sign.ac.uk/media/1056/sign118.pdf [cited 2020, Sep 22].

22. Stroke Foundation of New Zealand and New Zealand Guidelines Group. Clinical Guidelines for Stroke Management 2010. Wellington: Stroke Foundation of New Zealand; 2010. ISBN:(Electronic): 978-0-9582619-6-8
23. Hebert D, Lindsay MP, McIntyre A, Kirton A, Rumney PG, Bagg S, et al. Canadian stroke best practice recommendations: stroke rehabilitation practice guidelines, update 2015. Int J Stroke 2016,11:459-484.
24. Bowen A, James M, Young G. Royal College of Physicians, National clinical guideline for stroke. RCP 2016. Available from: https://www.strokeaudit.org/SupportFiles/Documents/Guidelines/2016-National-Clinical-Guideline-for-Stroke-5t-(1).aspx [cited 2020, Sep 22].
25. Winstein CJ, Stein J, Arena R, Bates B, Cherney LR, Cramer SC, et al. Guidelines for adult stroke rehabilitation and recovery: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2016;47:e98-e169.
26. Stroke Foundation. Clinical guidelines for stroke management 2017. Available from: https://strokefoundation.org.au/What-we-do/Treatment-programs/Clinical-guidelines [cited 2020, Sep 22].
27. Management of Stroke Rehabilitation Working Group. VA/DOD Clinical practice guideline for the management of stroke rehabilitation. J Rehabil Res Dev. 2010;47:1-43. PMID: 21213454.
28. Burridge J, Alt Murphy M, Buurke J, Feys P, Keller T, Klamroth-Marganska V, et al. A Systematic Review of International Clinical Guidelines for Rehabilitation of People With Neurological Conditions: What Recommendations Are Made for Upper Limb Assessment? Front Neurol. 2019;10:567.

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All authors read and approved the final version of the manuscript.

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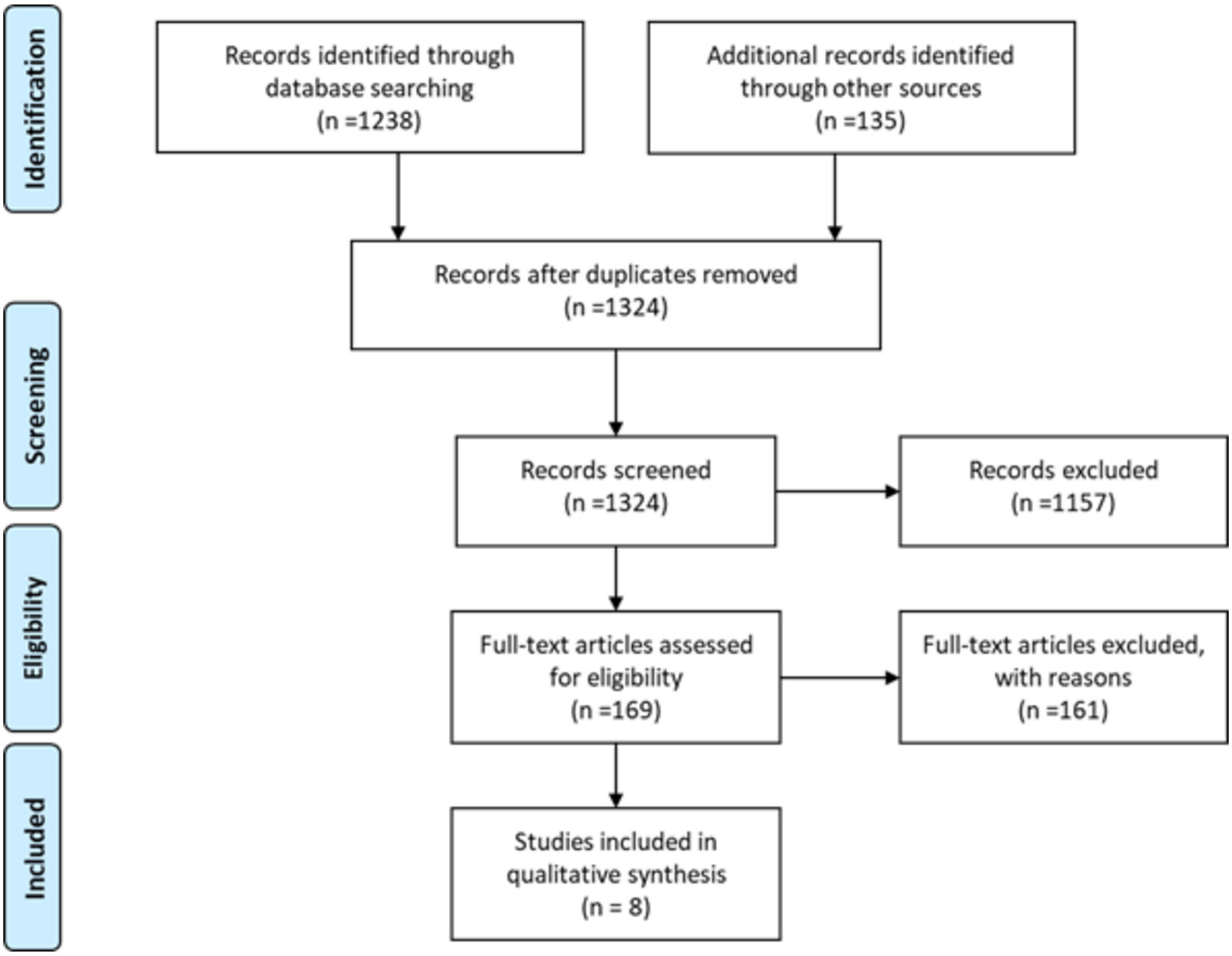
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Additional records identified through other sources (n =135)
Records after duplicates removed (n =1324)
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Full-text articles assessed for eligibility (n =169)
Full-text articles excluded, with reasons (n =161)
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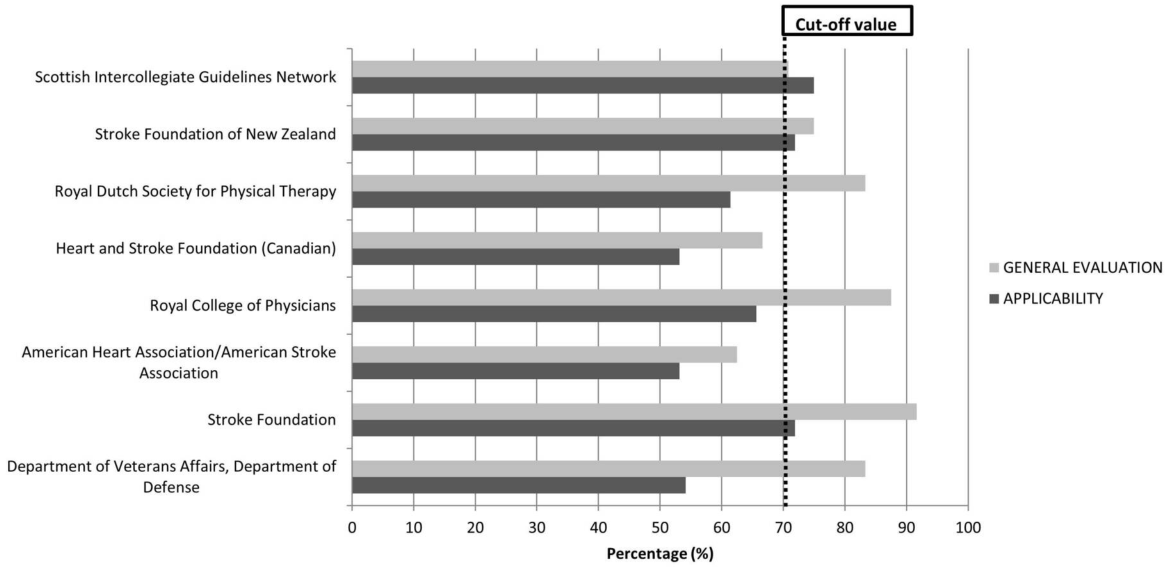
Cut-off value
Scottish Intercollegiate Guidelines Network
Stroke Foundation of New Zealand
Royal Dutch Society for Physical Therapy
Heart and Stroke Foundation (Canadian)
Royal College of Physicians
American Heart Association/American Stroke Association
Stroke Foundation
Department of Veterans Affairs, Department of Defense
0 10 20 30 40 50 60 70 80 90 100
Percentage (%)
GENERAL EVALUATION
APPLICABILITY

Supplementary Digital Material

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