

Strategies for Specialty Training of Healthcare Professionals in Low-Resource Settings: A Systematic Review on Evidence from Stroke Care

Junaid Habibi (✉ junaid.habibi@medportal.ca)

McMaster University <https://orcid.org/0000-0001-7543-0986>

Jackie Bosch

McMaster University School of Rehabilitation Science

Patrick Bidulka

London School of Hygiene & Tropical Medicine

Sarah Belson

Stroke Association

Vincent DePaul

Queen's University School of Rehabilitation Therapy

Dorcas Gandhi

Christian Medical College Department of Neurological Sciences

Anne Kumurenzi

McMaster University School of Rehabilitation Science

Rita Melifonwu

Stroke Action Nigeria

Jeyaraj Pandian

Christian Medical College Department of Neurological Sciences

Peter Langhome

University of Glasgow Institute of Cardiovascular and Medical Sciences

John Solomon

Manipal Academy of Higher Education

Dimple Dawar

Christian Medical College Department of Neurological Sciences

Sandra Carroll

McMaster University School of Nursing

Gerard Urimubenshi

University of Rwanda College of Medicine and Health Sciences

Martin Kaddumukasa

Makerere University School of Medicine

Leah Hamilton

Population Health Research Institute

Research article

Keywords: Low-resource, stroke, training, education, teaching, telehealth, multidisciplinary, task-sharing, train-the-trainer, workshop

Posted Date: September 27th, 2022

DOI: <https://doi.org/10.21203/rs.3.rs-1995056/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Version of Record: A version of this preprint was published at BMC Medical Education on June 16th, 2023. See the published version at <https://doi.org/10.1186/s12909-023-04431-w>.

Abstract

Background: The greatest mortality and disability from stroke occurs in low- and middle-income countries. A significant barrier to implementation of best stroke care practices in these settings is limited availability of specialized healthcare training. We conducted a systematic review to determine the most effective methods for the provision of speciality stroke care education for hospital-based healthcare professionals in low-resource settings.

Methods: We followed the PRISMA guidelines for systematic reviews and searched PubMed, Web of Science and Scopus for original clinical research articles that described or evaluated stroke care education for hospital-based healthcare professionals in low-resource settings. Two reviewers screened titles/abstracts and then full text articles. Three reviewers critically appraised the articles selected for inclusion.

Results: A total of 1,182 articles were identified and eight were eligible for inclusion in this review; three were randomized controlled trials, four were non-randomized studies, and one was a descriptive study. Most studies used several approaches to education. A “train-the-trainer” approach to education was found to have the most positive clinical outcomes (lower overall complications, lengths of stay in hospital, and clinical vascular events). When used for quality improvement, the “train-the-trainer” approach increased patient reception of eligible performance measures. When technology was used to provide stroke education there was an increased frequency in diagnosis of stroke and use of antithrombotic treatment, reduced door-to-needle times, and increased support for decision making in medication prescription was reported. Task-sharing workshops for non-neurologists improved knowledge of stroke and patient care. Multidimensional education demonstrated an overall care quality improvement and increased prescriptions for evidence-based therapies although there were no significant differences in secondary prevention efforts, stroke reoccurrence, or mortality rates.

Discussion: The “train the trainer” approach is likely the most effective strategy for specialist stroke education, while technology is also useful if resources are available to support its development and use. If resources are limited, basic knowledge education should be considered at a minimum, and multidimensional training may not be as beneficial. Communities of practice, led by those in similar settings, may be helpful to develop educational initiatives with relevance to local contexts.

Background

Stroke is the second leading cause of death worldwide,¹ and an estimated 86% of stroke deaths occur in low- and middle-income countries.² Rates of disability and mortality from stroke are 10 times greater in medically underserved regions in comparison to the world’s most developed nations,³ and the implementation of best practices in stroke care is especially difficult.⁴ In some areas, hospital-based healthcare professionals have low knowledge of stroke and its care,^{5,6} and according to the World Stroke Organization, the level of training for healthcare professionals varies, with formal training unavailable in many regions.⁷ Many barriers exist for healthcare professionals’ to obtain formal stroke care training, including lack of financial support for training, health policies and government priorities that may not include specialty stroke care training, limited training opportunities that are relevant to the culture and context, and a lack of evidence on the effectiveness of interventions in low-resource settings and subsequently the lacking existence of guidelines.⁸ A significant need exists for context-specific approaches to stroke care education for healthcare professionals in low-resource settings that address these barriers, and is evidence-based.

To better understand the optimal methods for providing training in low-resource settings, we searched for studies that addressed our research question “what are the optimal methods for educating hospital-based healthcare professionals in low-resource settings on stroke care”. We sought to describe and compare the reported impact of these interventions on knowledge, behaviours and outcomes in these environments. To our knowledge, no study has systematically analyzed primary literature to determine an optimal approach to stroke training in low-resource settings. This systematic review was conducted to provide clinicians and policy makers evidence and examples to aid in the development and implementation of specialty stroke care education for hospital-based healthcare professionals in low-resource settings.

Methods

This review was conducted according to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) systematic review approach.⁹

Eligibility Criteria

Original clinical research articles (descriptive or evaluative) were eligible if they described or evaluated stroke care education (any intervention or model for the treatment of stroke patients) for hospital-based healthcare professionals in low-resource settings. Healthcare professionals were defined to be any credentialed professional involved in stroke care, excluding patients, family, and other caregivers. Hospitals were defined as any healthcare facility, inpatient or outpatient, in which health professionals were present.

Search Strategy and Study Selection

A systematic search of the literature was conducted using the following databases: PubMed, Web of Science and Scopus.

Articles were imported into Covidence¹⁰ on February 3rd, 2021. Covidence was used for the independent screening of titles and abstracts together. All study designs were included, and references lists were hand searched for primary studies that may have been missed. Title and abstract screening were conducted by two reviewers (JH/LH). Articles describing original study results were eligible for full review if the study met the eligibility criteria. If consensus

was not reached at title and abstract screening, then full text screening took place. If at full text screening there was a lack of consensus, a third senior reviewer (JB) made the final decision on inclusion.

Data Extraction

The information extracted from each study included the lead author, year of publication, country of study, study design, participants/sample size, healthcare site characteristics, descriptions of educational strategies, description of educational aims, and the outcome measures, overall results, and comparisons included in studies.

Assessment of Methodological Quality

The methodological quality of the included studies was assessed by JH, SB, PB and VD using the Joanna Briggs Institute/University of Adelaide critical appraisal tools.¹¹

Identification of Themes

We did not meta analyse results because methods and outcome measures were too heterogenous. As such, the identified educational interventions were grouped into themes based on similar characteristics in their objectives.

Results

We identified 1082 records from which 964 were removed primarily because they did not describe educational approaches, were not specific to stroke training or did not occur in low-resources settings (Figure 1). A total of 118 articles went forward for full review, from which 109 were excluded, because they were: not original clinical research articles (49%), did not include any educational component in the intervention (20%), or did not discuss stroke (15%).

Study Characteristics

Eight articles describing eight educational interventions were eligible for inclusion in this systematic review (see Figure 1). Characteristics of the included studies and the educational interventions are available in Table 1. In summary, we identified three randomized controlled trials, one case series, two pre-post studies, one survey, and one descriptive study. Studies were conducted in Argentina, Brazil, China, Ghana, India, Nigeria and Peru and all except one were in an outpatient setting.

Critical Appraisal

A summary of the critical appraisal for randomized controlled trials are presented in Figure 2 and for non-randomized studies in Figure 3. Most studies were of satisfactory quality of evidence. However, there were some concerns. Specifically, the study by Sharma et al. was missing the total number of patients that were eligible for thrombolysis,¹² the study by Akinyemi et al. had relatively low pre-intervention survey completion at 55.2%,¹³ and the study by Johnson et al.¹⁴ was not evaluated for quality as it was descriptive in nature. Five studies could not be assessed for the 'bias due to deviations from intended interventions' category as no pre-study protocols were available.

Methods of Education Delivery

The studies used a variety of methods for delivery of education. The majority of studies (n=6) utilized more than one educational strategy. On-site training was used in seven studies. Within these studies, didactic lectures were used in two studies, workshops and interactive sessions were used in five studies, and live simulations were provided in two studies. Written materials for education such as guidelines, manuals, and roadmaps were provided in four studies. Videos and virtual training were both provided in two studies.

Details on the educational methods used for each study are provided in Table 1.

Overview of Themes in Stroke-Education Related Literature

Five themes emerged from the included interventions – 1) use of technology to provide education for stroke care, 2) on-site workshops for task-sharing education to develop knowledge on stroke for non-specialists, 3) “training-the-trainer” for the implementation of multidisciplinary stroke units, 4) “training-the-trainer” for quality improvement, and 5) multidimensional education for quality improvement, when multiple educational themes were present.

Use of Technology to Provide Education for Stroke Care

Three studies described interventions designed to support the implementation of technology in stroke care. First, a pre/post study in Brazil examined the effects of implementing a technology based “hub (one tertiary care centre) and spoke (five emergency departments)” model for improving the frequency and accuracy of stroke diagnosis and the quality of stroke care.¹⁵ The hub and spoke facilities were connected by a telemedicine technology that connected hub facility neurologists remotely to spoke facility desktops, to aid in the assessment of radiological images. To supplement this connectivity, spoke staff were provided brief lectures and live simulations on providing stroke care in teams. After education and implementation of the technology, the mean number of patients diagnosed with stroke increased from 7.5 to 16.58 per month (p=0.019). There was no significant change in the proportion of patients who received intravenous thrombolysis (TBL), which reduced from 21.31% to 18.18% (p=0.598). There was also a decrease in symptomatic intracranial hemorrhage rate from 12.5% to 7.69% (p=0.678), although not statistically significant. Mean door-to-needle time for delivery of thrombolytic agents was reduced from 137.1 to 95.5 minutes (p=0.001).

Secondly, a 2014 retrospective case series study of a WhatsApp-based “hub (2 tertiary facilities) and spoke (17 government district hospitals with no neurological service)” model in India examined the number of patients provided with TBL.¹² In addition to providing direct support via WhatsApp, spoke medical officers participated in education on stroke recognition and interpreting CT scans, and using WhatsApp to connect with the hub facility. Between June 2014 and May 2015, 26 patients received tissue plasminogen activator (TPA), which was a 100% increase since no patients were previously receiving this therapy. The number of TBL-eligible patients before and after the intervention’s implementation was not provided.

Third, researchers in China developed an android-based application to provide village doctors, township physicians, and county managers with education on secondary stroke prevention.¹⁶ They conducted a 1-year, cluster randomized controlled trial feasibility study in 50 villages, of which 25 were in the intervention group. 24 out of 25 (96%) village doctors in the intervention group responded in a post-trial survey. All respondents agreed or strongly agreed that the app was quick and easy to learn and supported decision making for medication prescription. Furthermore, 92% agreed or strongly agreed that they would continue using the app after the trial.

On-Site Workshops for Education on Task-Sharing to Develop Knowledge on Stroke for Non-Specialists

One survey study from Nigeria examined the use of task-sharing education for developing knowledge on stroke and its care amongst medical officers, nurses, and community health extension workers without any specialty neurological training.¹³ A one-day workshop provided basic information on stroke risk factors, symptoms, development, diagnosis, and treatment. Pre- and post-workshop self-administered stroke literacy questionnaires were completed, of which 55.2% and 91.0% were completed, respectively. Significant improvements in knowledge were noted across a variety of topics including knowledge of risk factors (90.5% vs. 99.0%, $p<0.001$), stroke symptoms identification (79.3% vs. 90.6%, $p<0.001$), the development of stroke (81.0% vs. 95.3%, $p=0.009$), swallowing tests (61.2% vs. 86.9%, $p<0.001$) and appropriate use of thrombolytics (62.9% vs. 85.9%, $p=0.002$).

Training the Trainer for the Implementation of Multidisciplinary Stroke Units

An Indian pre/post implementation study used a “train-the-trainer” approach to implement a stroke unit (SU).¹⁷ The trainer (one physician) was trained by local experts for two hours via video conference (Skype), three times a week for four weeks. The trainer then conducted two-hour training sessions with healthcare professionals in nursing, physiotherapy, and occupational therapy for five days per week over four weeks. After this training, the multidisciplinary team continued to meet weekly to discuss patient treatment. All training was augmented with the use of written care protocols. After the implementation of the stroke unit by the healthcare team after training, improvements were noted in the number of swallowing assessments (0% vs. 36.8%, $p<0.001$), mobility assessments and patient re-education for daily tasks (91.2% vs. 99.2%, $p=0.037$). The overall incidence of medical complications was significantly reduced (44.8% vs. 28.0%, $p<0.006$), as was length of stay (5 ± 2.68 vs. 4 ± 2.16 days, $p<0.026$). There was no significant difference in functional outcome at one-month between the groups, as recorded by the modified Rankin scale (good outcome 35.7% pre-SU vs. 39.6% post-SU, bad outcome 64.3% pre-SU vs. 60.4% post-SU, $p=0.552$).

A study from Ghana described the use of a “train-the-trainer” approach supported by healthcare professionals in the United Kingdom to implement a multidisciplinary stroke unit, in a program called the “Wessex-Ghana Stroke Partnership”.¹⁴ The approach was supported with teaching materials and a practical competency framework. Overall, education seemed to have positive effects on the intended outcome of developing an effective multidisciplinary stroke unit. Trainers (champions) were developed into leaders to oversee different health services within a hospital setting, and their efforts were supported by deputy trainers and link individuals that connected specialties in stroke care together. These individuals allowed for key skill areas in stroke care to develop, with deputy trainers being implemented with succession planning in mind. An emphasis was also placed on dismantling tendencies of units that were restrictive towards collaboration between hospital services, so that multidisciplinary care approaches could be developed amongst the healthcare team.

Training the Trainer for Quality Improvement

The “train-the-trainer” model was also used in a Chinese multicentre, cluster-randomized clinical trial to improve acute ischemic stroke (AIS) care with 2400 patients each in the intervention and control groups.¹⁸ The director of the neurology department and a nurse or physician from 20 hospitals in the study attended a two-day workshop on operational methods for stroke care, and then shared the information they learned with other professionals from their site. This was supported by written clinical pathways and protocols, as well as a quality coordinator at each hospital and a monitoring and feedback system. Patients in the intervention group were more likely to receive eligible performance measures when measures were assessed as a whole, after adjustment for patient and hospital baseline characteristics (88.2% vs. 84.8%, $p=0.003$, 95% CI 0.68% to 6.40%). When the reception of eligible performance measures was assessed as an all-or-none measure, more patients received eligible performance measures in the intervention group after adjustment, but this was not statistically significant (53.8% vs. 47.8%, $p=0.31$). New clinical vascular events were lower at 3 months (3.9% vs. 5.3%, $p=0.002$), 6 months (6.3% vs. 7.8%, $p=0.004$), and 12 months (9.1% vs. 11.8%, $p<0.001$) for the intervention group.

Multidimensional Education for Quality Improvement

A cluster randomized control trial from Brazil, Argentina, and Peru¹⁹ evaluated the effects of a multi-faceted quality improvement intervention for the treatment of patients presenting with acute ischemic stroke (AIS) and transient ischemic attack (TIA). A total of 19 sites were randomized to the intervention group (817 patients during primary analysis until discharge, 684 at 90-days follow-up). 16 hospitals were randomized to routine care (807 patients in primary analysis until discharge, 698 after 90 days follow-up). Analyses were adjusted for the cluster design and the presence of a stroke unit. Eligible patients in the intervention clusters received more prescriptions for evidence-based therapies than those in control clusters (73.5% vs. 58.7%). There were no significant differences between the intervention and control groups in secondary prevention efforts such as pharmaceuticals for hyperlipidemia,

hypertension, or diabetes. The intervention had no effect on stroke reoccurrence (1.3% vs. 0.6%, $p=0.13$), total mortality (12.6% vs. 11.8%, $p=0.58$), and cardiovascular mortality (2.1% vs. 1.7%, $p=0.42$). There were more hemorrhagic transformations identified in the intervention group compared to the control group (5.1% vs. 2.5%, $p=0.02$).

Discussion

We conducted a systematic review of studies examining stroke care education strategies for hospital-based healthcare professionals in low-resource settings, to better understand best practices for delivering speciality education.

A train-the-trainer approach for the implementation of multidisciplinary stroke units was the most used method for education and found to be effective in two studies examined in this review. Both improvements in patient care and professional skills were evident. External to this review, expert opinion provided in other articles regards multidisciplinary SUs to be a gold standard in stroke care with numerous benefits.^{4,20,21} A key strength of the “train-the-trainer” approach is potential sustainability – the Indian study by John et al. (2021)¹⁷ and Wessex-Ghana¹⁴ study by Johnson et al. (2017) demonstrated that healthcare professionals can educate their co-workers upon training, and the Wessex-Ghana Stroke Partnership has appointed deputies to support clinical leaders with the aim of succession planning. Furthermore, while a train-the-trainer approach may be effective and implemented with existing human resources, successful approaches, such as in the Wessex-Ghana Stroke Partnership, have involved significant input from external healthcare expert professionals. It is important to note that educational interventions with international partnerships that require the “train-the-trainer” approach may be time consuming – the intervention in India took two months, while the Wessex-Ghana Stroke Partnership took several years. The Wessex-Ghana study also required international professionals from the United Kingdom and grant funding, likely because local expertise did not exist. As local expertise grows, the need for international collaboration will likely decrease, with the added benefit of interventions becoming more tailored to the local context in the delivery of education.

Locally-created training videos on the Wessex-Ghana website are freely available.²² Other resources, such as the Core Competencies e-learning resource from the Stroke Training and Awareness Resources (STARs) project, are also available and accessible to learners with a varying knowledge-base.²³ However, educational resources and guidelines from the STARs project are from western high-resource settings, and as such may not always be relevant for global low-resource settings. More research is needed to determine if these resources and guidelines, or components of them, can be applicable to low-resource settings.

Of the care quality improvement initiatives, the study in China by Wang et al. (2018) with the “train-the-trainer” model had the most demonstrated potential.¹⁸ The deliverance of performance measures, when they were assessed as a whole, was increased and the occurrences of new clinical vascular events at 3, 6, and 12 months was decreased. In comparison, the South American study by Machline-Carrion et al. (2019) which also sought to implement overall care quality improvement had increased prescriptions for evidence-based therapies, but no significant differences in secondary prevention efforts, stroke reoccurrence, and mortality measures.¹⁹ Furthermore, the number of hemorrhagic transformations was increased, but it is unclear if this was due to improved detection, better recording of clinical notes, and/or confounding variables.

Three studies demonstrated that technology can be used to improve patient care in low-resource settings. A telemedicine model with advanced computing and imaging facilities like the one used in Brazil¹⁵ by Carvalho et al (2019) may be out of reach for some given the diversity of facilities in different regions. The Indian initiative by Sharma et al. (2016) used WhatsApp, a readily accessible and freely available mobile messaging application with end-to-end encryption.^{12,24} A study examining the perceptions of healthcare workers on how to improve the quality of stroke care in Ghana noted a recommendation for the use of technological tools like WhatsApp, which was thought to have the ability to promote collaborative or multidisciplinary care.⁸ In the Chinese study by Wu et al. (2019), village doctors and patients used a smartphone application for both communication and the provision of education.¹⁶ The overall reception of the implementation of smartphones was positive among village doctors in this study and it was perceived to improve their ability to provide healthcare. However, building a new application like in the Wu et al. (2019) study may not be feasible or necessary for some and therefore the use of WhatsApp or similar free messaging apps should be strongly considered. Finally, Wu et al. (2019) study noted that they chose android smartphones because they were relatively affordable and popular for their setting. The use of applications on android smartphones may be the most feasible avenue for delivering education on stroke diagnosis through technology. Technology use in stroke education may also augment the delivery of other educational models, such as the “train the trainer” approach by John et al. (2021)¹⁷ and the multidimensional approach by Machline-Carrion et al. (2019).¹⁹ However, in areas with limited connectivity to internet and cellular services, the use of technology may not be feasible until local infrastructure changes are made.

On-site workshops were used in Nigeria in a study by Baatiema et al. (2020) to provide non-specialists with knowledge on stroke and its care.¹³ Data were not provided on whether this approach improved patient care or outcomes, but the education of non-neurologist healthcare workers on stroke and patient care was demonstrated through literacy questionnaires. This indicates that simple strategies for sharing basic knowledge on stroke care in settings where there are no specialists may have potential in improving outcomes.^{5,6} In contrast, multidimensional educational training for nurses and physicians in Brazil, Argentina, and Peru by Machline-Carrion et al. (2019) had a variable effect on patient outcomes, suggesting that complex education may not be better.¹⁹

Although data are limited, it seemed that the “train the trainer” approach was most optimal in providing stroke care education. Technology can be useful as well and if resources are limited, basic education should be considered at a minimum. Previous surveys have shown that health professionals in low-resource settings consider education to be helpful and prefer to do so in workshop and conference formats.^{8,25,26} An approach that may be helpful is the establishment of communities of practice so that local contexts can be considered in the design of educational interventions. The African Stroke Organization (ASO) is an example of a community of practice for stroke care professionals.²⁷ The ASO is composed of stroke researchers, clinicians, allied

healthcare professionals, stroke care societies, and stroke support organizations in Africa. Annual conferences are planned in which knowledge gaps on stroke are addressed, research is enhanced, collaboration between African regions is increased, priorities for care delivery are guided, and leaders are built. The Organized Stroke Care Across Income Levels (OSCAIL) study is another example of a community of practice, with healthcare professionals from high and low-resource settings collaborating with an aim to improve post-stroke outcomes through simple evidence-based strategies.²⁸

While our review is comprehensive, there are some major limitations. Firstly, we could not meta analyse results as the studies were too heterogenous in their methodologies and measured outcomes. Secondly, some studies did not evaluate the impact of training interventions directly on patients. Thirdly, there was no clear definition of what constitutes an effective intervention. Fourthly, we were unable to determine if the changes observed in individual studies were due to Hawthorne effects, improvements in data capture over time, or other biases. Finally, multiple educational strategies were used in some studies, making it difficult to clearly identify the individual impacts of the educational components.

The quality of evidence of the included articles was generally satisfactory. Randomized control trial methods in future studies can reduce the risk of biases and increase the level of confidence in the results.

Conclusions

This systematic review demonstrates that different educational interventions have the potential to deliver positive results for speciality stroke care education in low-resource settings for hospital-based healthcare professionals. A “train-the-trainer” approach to education was deemed to have the most potential, with technology use also being promising. Regardless of resources, basic education for the development of knowledge on stroke and its care should be considered as a minimum requirement. Multidimensional approaches to education for care improvement may not have as much potential as other approaches. We ultimately recommend that an emphasis should be placed on designing educational interventions within communities of practice so that local contexts are considered.

Abbreviations

PRISMA - Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

TBL – Intravenous thrombolysis.

TPA – Tissue plasminogen activator.

SU – Stoke unit.

STARs - Stroke Training and Awareness Resources.

AIS - Acute ischemic stroke.

TIA - Transient ischemic attack.

Declarations

Ethics approval and consent to participate: Not applicable.

Consent for publication: Not applicable.

Availability of data and materials: Database search strings are available from the corresponding author on reasonable request.

Competing interests: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Funding: Not applicable.

Authors' contributions: JH screened articles for inclusion in this review, collected data, wrote the manuscript, and contributed to the assessment of methodological quality for the included studies. JB resolved any conflicts in screening articles for inclusion in this review, aided in the editing of the manuscript, and guided the overall project. PB, SB, and VD equally contributed to the assessment of methodological quality for the included articles and aided in the editing of the manuscript. DG, AK, RM, JP, PL, JMS, DD, and SC equally aided in the editing of the manuscript. GU and MK equally aided in the collection of data. LH screened articles for inclusion in this review, aided in the editing of the manuscript, and guided the overall project. All authors read and approved the final manuscript.

Acknowledgements: Not applicable.

References

1. Donkor ES. Stroke in the 21st Century: A Snapshot of the Burden, Epidemiology, and Quality of Life. *Stroke Res Treat* [Internet]. 2018 [cited 2022 May 2];2018. Available from:
2. Owolabi MO, Akarolo-Anthony S, Akinyemi R, Arnett D, Gebregziabher M, Jenkins C, et al. The burden of stroke in Africa: A glance at the present and a glimpse into the future. *Cardiovasc J Afr* [Internet]. 2015 Mar 1 [cited 2022 May 2];26(2):S27–38. Available from: <https://pubmed.ncbi.nlm.nih.gov/25962945/>
3. Norrving B, Kissela B. The global burden of stroke and need for a continuum of care. *Neurology* [Internet]. 2013 Jan 15 [cited 2022 May 2];80(3 SUPPL.2). Available from: <https://pubmed.ncbi.nlm.nih.gov/23319486/>
4. Langhorne P, de Villiers L, Pandian JD. Applicability of stroke-unit care to low-income and middle-income countries. *Lancet Neurol* [Internet]. 2012 Apr [cited 2022 May 2];11(4):341–8. Available from: <https://pubmed.ncbi.nlm.nih.gov/22441195/>
5. Shehata HS, Ahmed SM, Abdelalim AM, El Sherbiny N. Knowledge and attitude towards stroke among workers in Cairo University Hospitals. *Egypt J Neurol Psychiatry Neurosurg* [Internet]. 2016 Jan 1 [cited 2022 May 2];53(1):54. Available from: <http://www.ejnprn.eg.net/text.asp?2016/53/1/54/176374>
6. Akinyemi RO, Ogah OS, Ogundipe RF, Oyesola OA, Oyadoke AA, Ogunlana MO, et al. Knowledge and perception of stroke amongst hospital workers in an African community. *Eur J Neurol* [Internet]. 2009 Sep [cited 2022 May 2];16(9):998–1003. Available from: <https://pubmed.ncbi.nlm.nih.gov/19486134/>
7. Gubitz G, Saini M, Belson S, Sahathevan R, Sandercock P. How can the World Stroke Organization (WSO) optimize education in stroke medicine around the world? Report of the 2018 WSO Global Stroke Stakeholder Workshop. In: *International Journal of Stroke* [Internet]. SAGE Publications Inc.; 2019 [cited 2022 May 2]. P. 803–5. Available from: <https://pubmed.ncbi.nlm.nih.gov/31506027/>
8. Baatiema L, de-Graft Aikins A, Sarfo FS, Abimbola S, Ganle JK, Somerset S. Improving the quality of care for people who had a stroke in a low-/middle-income country: A qualitative analysis of healthcare professionals' perspectives. *Heal Expect* [Internet]. 2020 Apr 1 [cited 2022 May 2];23(2):450–60. Available from: <https://pubmed.ncbi.nlm.nih.gov/31967387/>
9. Moher D, Liberati A, Tetzlaff J, Altman DG, Altman D, Antes G, et al. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PloS Med* [Internet]. 2009 Jul [cited 2022 May 2];6(7). Available from: <https://pubmed.ncbi.nlm.nih.gov/19621072/>
10. Veritas Health Innovation. Covidence [Internet]. 2021 [cited 2022 May 2]. Available from: <https://www.covidence.org/>
11. Joanna Briggs Institute, The University of Adelaide. Critical Appraisal Tools [Internet]. 2021 [cited 2022 May 2]. Available from: <https://jbi.global/critical-appraisal-tools>
12. Sharma S, Padma M, Bhardwaj A, Sharma A, Sawal N, Thakur S. Telestroke in resource-poor developing country model. *Neurol India* [Internet]. 2016 Sep 1 [cited 2022 May 2];64(5):934. Available from: <http://www.neurologyindia.com/text.asp?2016/64/5/934/190243>
13. Akinyemi RO, Owolabi MO, Adebayo PB, Akinyemi JO, Otubogun FM, Uvere E, et al. Task-shifting training improves stroke knowledge among Nigerian non-neurologist health workers. *J Neurol Sci* [Internet]. 2015 Dec 15 [cited 2022 May 2];359(1–2):112–6. Available from: <https://pubmed.ncbi.nlm.nih.gov/26671098/>
14. Johnson L, Akpalub A, Ananeb D, Cudjoe C, Easton S, Laryeab R, et al. Multi-Disciplinary Stroke Care in Developing Countries – Lessons from the Wessex-Ghana Stroke Partnership. *South Sudan Med J* [Internet]. 2017 Nov [cited 2022 May 2];10(4). Available from: <http://www.southsudanmedicaljournal.com/archive/november-2017/multi-disciplinary-stroke-care-in-developing-countries-lessons-from-the-wessex-ghana-stroke-partnership.html>
15. Carvalho VS, Picanço MR, Volschan A, Bezerra DC. Impact of simulation training on a telestroke network. *Int J Stroke* [Internet]. 2019 Jul 1 [cited 2022 May 2];14(5):500–7. Available from: <https://pubmed.ncbi.nlm.nih.gov/30040047/>
16. Wu N, Gong E, Wang B, Gu W, Ding N, Zhang Z, et al. A smart and multifaceted mobile health system for delivering evidence-based secondary prevention of stroke in rural China: Design, development, and feasibility study. *JMIR mHealth uHealth* [Internet]. 2019 [cited 2022 May 2];7(7). Available from: <https://pubmed.ncbi.nlm.nih.gov/31325288/>
17. John L, William A, Dawar D, Khatter H, Singh P, Andrias A, et al. Implementation of a Physician-Based Stroke Unit in a Remote Hospital of North-East India-Tezpur Model. *J Neurosci Rural Pract* [Internet]. 2021 Feb 22 [cited 2022 May 2]; Available from: <http://www.thieme-connect.de/DOI/DOI?10.1055/s-0041-1723099>
18. Wang Y, Wang Y, Li Z, Zhao X, Wang C, Wang X, et al. Effect of a multifaceted quality improvement intervention on hospital personnel adherence to performance measures in patients with acute ischemic stroke in China: A randomized clinical trial. *JAMA* [Internet]. 2018 Jul 17 [cited 2022 May 2];320(3):245–54. Available from: <https://pubmed.ncbi.nlm.nih.gov/29959443/>
19. Machline-Carrion MJ, Santucci EV, Damiani LP, Bahit MC, Málaga G, Pontes-Neto OM. Effect of a Quality Improvement Intervention on Adherence to Therapies for Patients With Acute Ischemic Stroke and Transient Ischemic Attack: A Cluster Randomized Clinical Trial. *JAMA Neurol*. [Internet]. 2019 Aug 1 [cited 2022 May 2]; 76(8):932-941. Available from <https://pubmed.ncbi.nlm.nih.gov/31058947/>
20. Cisse FA, Damien C, Bah AK, Touré ML, Barry M, Djibo Hamani AB, et al. Minimal setting stroke unit in a sub-Saharan African public hospital. *Front Neurol* [Internet]. 2019 [cited 2022 May 2];10(JUL). Available from: <https://pubmed.ncbi.nlm.nih.gov/31447769/>
21. de Villiers L, Kalula SZ, Burch VC. Does multidisciplinary stroke care improve outcome in a secondary-level hospital in South Africa? *Int J Stroke* [Internet]. 2009 [cited 2022 May 2];4(2):89–93. Available from: <https://pubmed.ncbi.nlm.nih.gov/19383048/>
22. Wessex Ghana Stroke Partnership. Training Films [Internet]. 2016 [cited 2022 May 2]. Available from: <http://www.wgstroke.org/training-materials>
23. CHSS eLearning. Stroke Training and Awareness Resources (STARs) Core Competencies. 2020 [cited 2022 May 2]. Available from: <https://www.chsselearning.org.uk/core-competencies/>

24. WhatsApp LLC. WhatsApp [Internet]. 2022. [cited 2022 May 2]. Available from: <https://www.whatsapp.com/>

25. Baatiema L, Otim M, Mnatzaganian G, Aikins ADG, Coombes J, Somerset S. Towards best practice in acute stroke care in Ghana: A survey of hospital services. BMC Health Serv Res [Internet]. 2017 Feb 2 [cited 2022 May 2];17(1). Available from: <https://pubmed.ncbi.nlm.nih.gov/28153014/>

26. Ibikunle PO, Onwuakagba IU, Maduka EU, Okoye EC, Umunna JO. Perceived barriers to evidence-based practice in stroke management among physiotherapists in a developing country. J Eval Clin Pract [Internet]. 2020 [cited 2022 May 2];27(2). Available from: <https://pubmed.ncbi.nlm.nih.gov/32424823/>

27. Akinyemi OR, Brainin M. The African Stroke Organization – a new dawn for stroke in Africa. Nat Rev Neurol [Internet]. 2021 [cited 2022 May 2];17(3). Available from: <https://www.nature.com/articles/s41582-021-00456-1>

28. Population Health Research Institute. OSCAIL [Internet]. 2022 [cited 2022 May 2]. Available from: <https://www.phri.ca/research/oscail/>

Table 1

Table 1: Characteristics of included studies. *Should appear after “Study Characteristics” section of Results.*

Lead Author (Year), Country	Study Designs, Descriptive/Evaluative	Themes	Participants/Sample Sizes	Healthcare Site Characteristics	Description of Educational Strategies	Included Comparisons/Outcomes
Carvalho Jr (2019), Brazil ¹⁵	Retrospective pre-/post, Evaluative	Use of Technology to Provide Education for Stroke Care	Professionals: - 122 attendees Patients: - 90 patients pre-intervention - 199 patients post-intervention	1 "hub" facility: - Neurologists - Remote access of spoke facility desktops for assessment of radiological images 5 "spoke" community Eds with: - Laboratories - Computed tomography (CT) scanners - Telemedicine technologies - One with magnetic resonance imaging machine	- "Hub" facility neurologists provided training to all emergency department staff in the "spoke" facilities - Brief lectures - Live simulations - Encouragement for teamwork	Included comparisons (evaluative): - Number of stroke diagnoses - Door-to-needle time - TBL rates - Symptomatic intracranial hemorrhage rates
Sharma (2016), India ¹²	Retrospective pre-/post case series, Evaluative	Use of Technology to Provide Education for Stroke Care	Professionals: - 4 neurologists - Medical officers (medicine graduates and internal medicine postgraduates), total unknown Patients: - Total unknown - 22 patients received TBL	2 tertiary "hub" facilities with: - Neurologists - "WhatsApp" for radiological image examinations and consultations 17 "spoke" government-run district hospitals: - CT scan facilities - Tissue plasminogen activator - "WhatsApp" to share radiological images	- Medical officers from district hospitals attended workshops on stroke recognition and CT scans	Included comparisons (quantitative): - Number of patients that received TBL
Wu (2019), China ¹⁶	Cluster randomized control trial, Evaluative	Use of Technology to Provide Education for Stroke Care	Professionals: - Village doctors - Township hospital healthcare providers - County managers	- Each village had a village doctor - 50 villages, 25 villages in intervention arm	- Empowered the existing workforce with ability to deliver and promote secondary prevention of stroke in a guideline-based manner, through use of and education from a mobile health (mHealth) app	Included information from survey results of the main trial (quantitative): - Village doctor's education on a 5-level Likert scale with questions regarding education on ease and speed of learning how to use app, app's aid in prescribing education, and enthusiasm for continued app usage
Akinyemi (2015), Nigeria ¹³	Pre-/post survey, Evaluative	On-Site Workshops for Education on	Professionals:	- Two federal tertiary	- One-day basic stroke course	Included comparisons (quantitative):

		Task-Sharing to Develop Knowledge on Stroke for Non-Specialists	<ul style="list-style-type: none"> - 210 non-neurologist health workers (medical officers, nurses, and community health extension workers) 	healthcare centers	<ul style="list-style-type: none"> - Didactic presentations - Educational stroke documentary film - Practical/interactive sessions on cases 	<ul style="list-style-type: none"> - Knowledge of risk factors, stroke symptoms, development of stroke, swallowing tests, and use of thrombolytics
John (2021), India ¹⁷	Pre-/post cohort study, Evaluative	Training the Trainer for the Implementation of Multidisciplinary Stroke Units	<p>Professionals:</p> <ul style="list-style-type: none"> - 1 internal medicine physician, 126 nurses, 2 physiotherapists, and 1 occupational therapist <p>Patients:</p> <ul style="list-style-type: none"> - 125 before stroke unit (pre-SU) - 125 after SU (post-SU) - Both groups age and gender matched 	<p>Secondary care hospital with:</p> <ul style="list-style-type: none"> - CT scanner - Six SU beds - No neurologist 	<ul style="list-style-type: none"> - Physician was trained first over Skype for 2-hour sessions that occurred three times a week, over the course of a month - Physician then trained other professionals in 2-hour sessions that were conducted for 5 days a week, over 1 month - Stroke unit manual was developed and written by the research group - Multidisciplinary teams were developed to meet once a week 	<p>Included comparisons (quantitative):</p> <ul style="list-style-type: none"> - Overall incidence of complications - Lengths of hospital stay - Rates of swallowing assessment, mobility assessment and patient re-education - Observed functional outcomes after 1-month follow up, as recorded by using the modified Rankin scale
Johnson (2017), Ghana ¹⁴	Descriptive	Training the Trainer for the Implementation of Multidisciplinary Stroke Units	<p>Professionals:</p> <ul style="list-style-type: none"> - Multidisciplinary team of 3 physiotherapists, 1 occupational therapist, 1 speech language therapist, and 1 stroke physician from the Southwest of England¹³ - Professionals from the hospital 	Korle Bu Teaching Hospital Accra	<ul style="list-style-type: none"> - Workshops on the clinical aspects of stroke management included presentations and small group discussions - Leaders from medicine, nursing, and physiotherapy were identified and trained in clinical knowledge, skills, and developing leadership qualities - Deputy leaders were also appointed to work with the clinical leaders and for succession planning - These leaders took responsibility for leading their respective services and educating their professional groups on core skills 	<p>Outcomes included (qualitative):</p> <ul style="list-style-type: none"> - Results from implementing the "train the trainer" model for creating a multidisciplinary SU¹⁴
Wang (2018), China ¹⁸	Randomized clinical trial, Evaluative	Training the Trainer for Quality Improvement	<p>Professionals:</p> <ul style="list-style-type: none"> - Personnel that took care of acute ischemic stroke (AIS) patients <p>Patients:</p> <ul style="list-style-type: none"> - 4800 patients hospitalized with AIS, 2400 in intervention group and 2400 in control group - Mean number of patients in each 	<p>Inclusion criteria:</p> <ul style="list-style-type: none"> - Secondary or tertiary centre - EDs - Neurological wards - Capacity to administer intravenous rtPA <p>Characteristics:</p>	<ul style="list-style-type: none"> - Neurology department director and physician or nurse from each site attended a 2-day workshop - These professionals were then tasked with sharing operational methods with personnel from their sites - An evidence-based clinical pathway written by a panel of stroke experts was provided 	<p>Included comparisons (quantitative):</p> <ul style="list-style-type: none"> - Patients receiving eligible performance measures (assessed as a whole and as all-or-none measure) - New clinical vascular events at 3, 6, and 12 months

			<p>cluster was 120 (range:102-145)</p> <p>- 3980 (82.9%) patients at 12-month follow-up, 2003 (83.5%) in intervention group and 1977 (82.4%) in control group</p>	<p>- Intervention and control groups composed of 20 hospitals each</p> <p>- 72.5% were tertiary hospitals</p> <p>- 62.5% had a stroke unit</p> <p>- 62.5% were teaching hospitals</p> <p>- Median annual number of beds of neurological wards was 77 (IQR: 61-178)</p>	<p>- Written care protocols for implementation of performance measures were provided</p> <p>- Full-time quality coordinator at each site and monitoring and feedback system for performance measures was implemented</p>	
Machline-Carrion (2019), Brazil, Argentina, and Peru ¹⁹	Cluster randomized clinical trial, Descriptive	Multidimensional Education for Quality Improvement	<p>Patients:</p> <p>- Diagnosed with AIS or transient ischemic attack (TIA)</p> <p>Hospitals:</p> <p>- 19 hospitals randomized to intervention (817 patients in primary analysis until discharge, 684 at 90 days follow-up)</p> <p>- 16 hospitals randomized to routine care (807 patients in primary analysis until discharge, 698 after 90 days follow-up)</p> <p>Professionals:</p> <p>- Physicians</p> <p>- Nurses</p>	<p>Inclusion Criteria:</p> <p>- 24-hour emergency care, with at least 1 physician in charge for the unit for 24 hours</p> <p>- 1 on-call neurologist</p> <p>- Central nervous system (CNS) imaging and alteplase therapy available</p> <p>Characteristics:</p> <p>- 47.2% stroke units</p> <p>- 88.9% intra-arterial TBL capabilities 24 hours a day</p> <p>- 77.8% teaching hospitals</p> <p>- Median ED volume 1500 patients/month (IQR: 500-3700)</p>	<p>Educational strategy:</p> <p>- 2 healthcare professionals from each hospital attended a simulation-based workshop on implementing the intervention</p> <p>- On-site training visits for training healthcare professionals on their hospital's clinical pathway</p> <p>- Web and telephone training</p> <p>- Audit and feedback reports</p> <p>- Roadmap with therapeutic plan</p> <p>- Checklists for following therapeutic plan</p> <p>- Educational posters</p> <p>- Video on training techniques</p>	<p>Included comparisons (quantitative):</p> <p>- Prescriptions for evidence-based therapies</p> <p>- Secondary prevention efforts</p> <p>- Stroke reoccurrence</p> <p>- Total mortality</p> <p>- Cardiovascular mortality</p> <p>- Hemorrhagic transformations</p>

Superscript numbers indicate article citations from the reference list. Bold text indicates table headers.

Figures

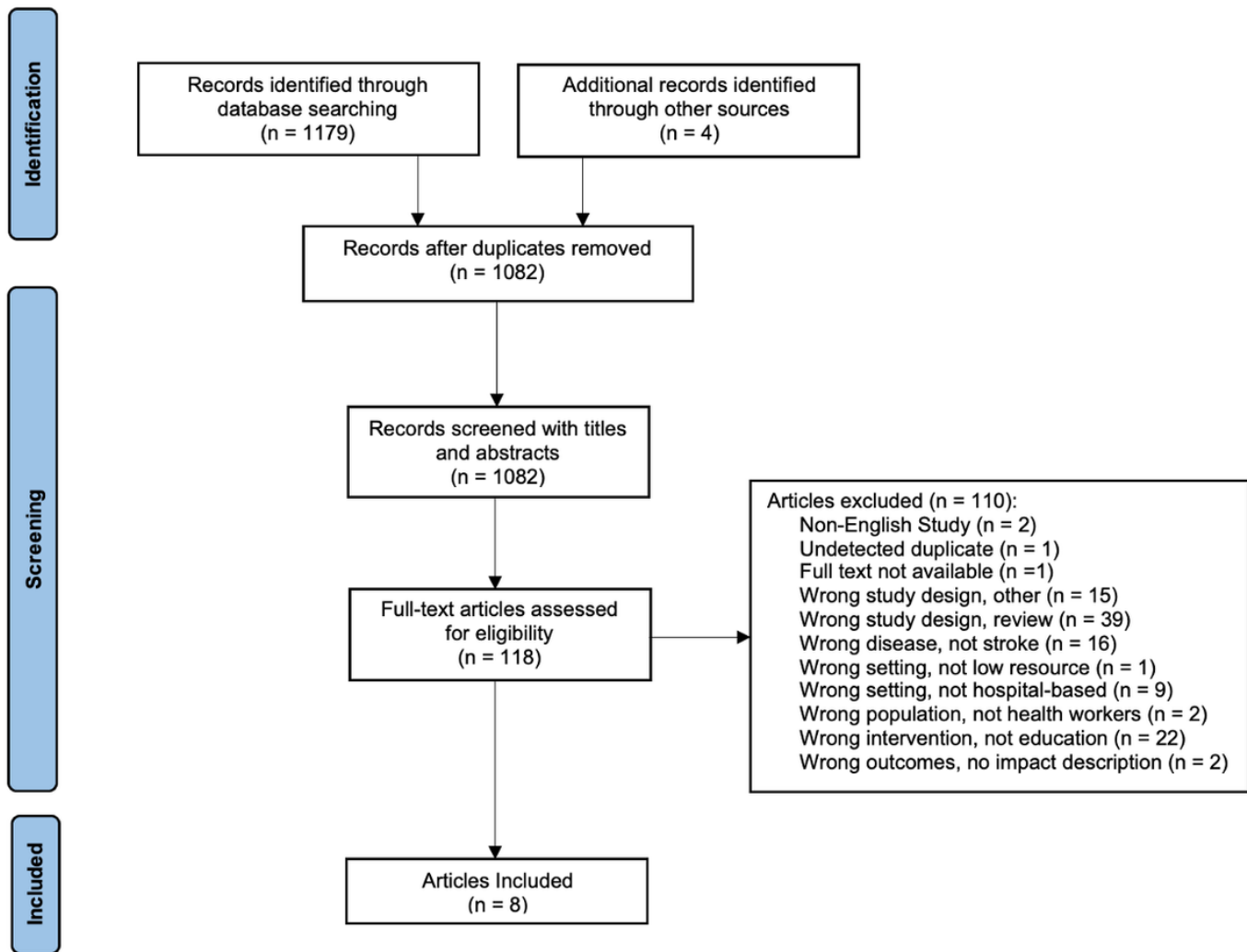


Figure 1

Flow chart for study screening and selection using PRISMA methodology. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for systematic reviews were followed in the screening of studies for inclusion in this systematic review. Covidence was used to screen studies gathered from databases. Presented reasons for study exclusion in full-text screening were ordered by JH and LH in order of perceived importance. A flow chart template was derived from the guidelines of the PRISMA organization and was modified with study screening data from Covidence.

	Bias due to confounding	Bias due to selection of participants	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported results
Carvalho (2019), Brazil ¹⁵	Yellow	Green	Green	Unable to Assess	Yellow	Yellow	Green
Sharma (2016), India ¹²	Red	Red	Yellow	Unable to Assess	Yellow	Red	Red
Akinyemi (2015), Nigeria ¹³	Red	Yellow	Green	Unable to Assess	Red	Yellow	Green
John (2021), India ¹⁷	Green	Green	Green	Unable to Assess	Yellow	Yellow	Green

Figure 2

Critical Appraisal of Randomized Studies. The methodological quality of the included studies was determined by JH after consideration of assessments done by JH, SB, PB and VD, using the Joanna Briggs Institute/University of Adelaide critical appraisal tools. Study first authors, years of publication, and country of origin are listed vertically, and different biases are listed horizontally. A “traffic light” model was used to describe concerns for various biases. Low, some, and high concerns for biases were indicated with green, yellow, and red colours respectively.

	Bias due to confounding	Bias due to selection of participants	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported results
Carvalho (2019), Brazil ¹⁵	Yellow	Green	Green	Unable to Assess	Yellow	Yellow	Green
Sharma (2016), India ¹²	Red	Red	Yellow	Unable to Assess	Yellow	Red	Red
Akinyemi (2015), Nigeria ¹³	Red	Yellow	Green	Unable to Assess	Red	Yellow	Green
John (2021), India ¹⁷	Green	Green	Green	Unable to Assess	Yellow	Yellow	Green

Figure 3

Critical Appraisal of Non-Randomized Studies. The methodological quality of the included studies was determined by JH after consideration of assessments done by JH, SB, PB and VD, using the Joanna Briggs Institute/University of Adelaide critical appraisal tools. Study first authors, years of publication, and country of origin are listed vertically, and different biases are listed horizontally. A “traffic light” model was used to describe concerns for various biases. Low, some, and high concerns for biases were indicated with green, yellow, and red colours respectively.