Stroke systems of care in South-East Asia Region (SEAR): commonalities and diversities

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Summary

The Southeast Asia Region (SEAR) accounts for nearly 50% of the developing world's stroke burden. With various commonalities across its countries concerning health services, user awareness, and healthcare-seeking behavior, SEAR still presents profound diversities in stroke-related services across the continuum of care. This review highlights the numerous systems and challenges in access to stroke care, acute stroke care services, and health care systems, including rehabilitation. The paper has also attempted to compile information on the availability of stroke specialized centers, Intravenous thrombolysis (IVT) ready centers, Endovascular therapy (EVT) ready centers, rehabilitation centers, and workforce against a backdrop of each country's population. Lastly, the efforts of WHO (SEARO)-CMCL (World Health Organization-South East Asia region, Christian Medical College & Hospital Ludhiana) collaboration towards improving stroke services and capacity among the SEAR have been described.

Keywords: Stroke; Systems of care; Acute care; Rehabilitation; Southeast Asia

Introduction

The Southeast Asia Region (SEAR) has been divided and classified differently based either on geographical or organizational domains. While geographically the region comprises all countries from east of India to south of China, the World Health Organization (WHO) classifies the SEAR as comprising 11 member countries: Bangladesh, Bhutan, India, Indonesia, Maldives, Myanmar, Nepal, Democratic People's Republic of Korea, Sri Lanka, Thailand, and Timor Leste. The SEAR constitutes a quarter of the world's population, occupying up to 3% of the earth's total geographical area.[1] Currently, this region accounts for nearly half of the developing world's stroke burden and is the largest contributor to stroke-related mortality globally.[2] Amongst the stroke survivors, up to one-third are severely disabled, and the rest carry a high risk of stroke recurrence.[3]

However, there exists a wide gap between the availability of stroke care services and the high burden of stroke in this region. Categorized under the low-and-middle-income group of countries (World Bank), there is a lack of both infrastructural facilities and qualified personnel in the SEAR. Distinctive features such as a higher prevalence of intracerebral hemorrhage, intracranial atherosclerosis, and venous thrombosis characterize stroke in the SEAR. These factors on the background of aging populations, differing geographical landscapes, and sociocultural diversities challenge the uniform delivery of stroke care in this region. Improving acute care in the SEAR remains inadequate, with low rates of thrombolysis, thrombectomies, and the number of Stroke Units (SU). Post-stroke rehabilitation remains largely unaddressed, with disparities in the availability of services and inadequacies in the knowledge and expertise of rehabilitation professionals. Reintegration into the community is another neglected but vital concern in this region.

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We conducted a review to highlight the current stroke systems of care, barriers, and facilitators and to propose holistic and sustainable approaches to implementing stroke care services in SEAR. Building on published literature, further supplemented by interactions with experts providing stroke care in the SEAR countries, the current state of stroke care systems in the SEAR countries is consolidated in this review.

Stroke systems of care and challenges to stroke services in SEAR

Access to stroke care

Awareness of stroke symptoms and signs among the public is low in SEAR. Knowledge and awareness studies from India have reported ignorance of warning stroke symptoms in up to 23–48% of the respondents, with more than 50% lacking awareness of risk factors or treatment for stroke.[4,5] A study in Sri Lanka among patients with stroke reported a mean stroke awareness of 47.79% ± 14.6, with better awareness among those with higher education.[6] Incorrect perceptions about stroke and sociocultural beliefs in indigenous modalities like faith healing result in many patients not seeking effective medical treatment despite timely recognition.[7]

Poorly structured pre-hospital services further contribute to delays in accessing stroke-ready centers. Established Emergency Medical Services (EMS) are lacking in most countries and, when available, vary in accessibility. India, which bears a significant burden of stroke among the SEAR, lacks an established EMS system in most states.[8] Patients usually use self-owned or hired private vehicles to arrive at hospitals. Only 1–13% of patients in India use EMS to reach the hospital, compared to 50% in high-income countries.[9,10] The 108-ambulance system is established in 22 out of 28 states and 2 out of 8 union territories in India. However, the focus remains on maternal and trauma care, and lacks paramedical staff trained in stroke care. In Sri Lanka, the national ambulance transport system Suwaseriya is available for patients at a 1990 toll-free number.[11] Although the public awareness and utilization of this service has improved, paramedic training in stroke recognition and fast-track referrals is needed. In Nepal, frequent landslides and rudimentary ambulance services challenge the delivery of rapid access to care. Despite better-structured systems in Thailand, previous studies report that only 5.5–20.5% of stroke patients utilize EMS.[12,13] Disorganized integration of fast-track protocols with EMS systems further results in only one-half of the suspected stroke patients being prioritized and transported to the appropriate stroke centers by EMS.[14] Maldives reports a robust referral system. Despite the topographic challenge of being a group of scattered islands, the air and sea ambulance services in the Maldives are uniquely adapted and well-developed for rapid transport and referral of patients.[15]

Acute stroke care

Even though acute stroke care services have steadily improved in SEAR, they remain inadequate, with disparities in availability and consistency. Access to, and utilization of evidence-based acute stroke treatment regimens such as thrombolysis is still low.[16,17] Dismal rates of IVT usage from 0.5 to 3.6% have been reported by various region-specific studies from India.[18,19] The more recent Indo-US registry reports a thrombolysis rate of 11.5%; however, representing only five major tertiary institutes of the country, this data is unlikely to truly reflect the national thrombolysis rates.[20]

Lack of public awareness, inadequate stroke-ready centers, delays in arrival at the hospital, and high medication costs are some of the key contributory factors resulting in low utilization of IVT in this region. Refusal to consent (10.7%) and unaffordability (9.8%) were reported in a study from Northwest India.[18] Compared to HICs, striking disparities exist in the availability of neurologists in Southeast Asia. With fewer than 4500 neurologists in the entire region, most SEAR countries have an average of 1 neurologist per 1 million population.[21] Bhutan currently has no neurologists in the region. Therefore, many of these countries rely on physicians to manage stroke, often leading to delays in diagnosis and referral to stroke-ready centers.[19] Lack of easy and timely access to neuroimaging further challenges managing acute stroke. In Sri Lanka, despite the availability of IVT in 97% of tertiary hospitals, the use is limited by the provision of neuroimaging in only 59% of centers.[22] Although the number of stroke units (SUs) in this region has increased, the number of units equipped to provide acute care is still limited. Since 1999, Thailand has had the largest growth in the number of SUs, from 1 to 116. However, countries such as India report only around 400–500 SUs in a population of 1.4 billion, while Nepal has only 2 SUs.[23] Moreover, a wide urban-rural divide exists in the accessibility of these services. Most comprehensive stroke care facilities, as well as the availability of specialist neurologists, are urban-centric, directing that within the same country, patients with stroke in a city may have easier access to evidenced-based care compared to those residing in remote, rural regions.[24]

The advent of endovascular thrombectomy in SEAR began in 2008 when the first-generation device was launched in Singapore.[25] It is only after the surge of positive results from EVT trials in 2015 that newer, improved devices were introduced into the region. Over time, the SEAR has witnessed a dramatic increase in the number of EVT procedures; however, in 2016, most countries did not perform even one procedure per 100,000 population when assessed individually.[21] Four out of the eleven countries completely lack EVT services.

Recently, the European Stroke Organization has recommended the availability of at least one comprehensive stroke center (ideal 7–8) per million people. To put this into perspective, with less than 400 EVT-ready centers and 250 neuro-interventionists in a country like India, there are just 0.1 stroke centers and 0.2 neuro-interventionists for every 1 million population.[26] The principal reasons for this lag are the slow bureaucratic processes, disproportionate access to thrombectomy centers with urban-centric locus, high cost of treatment with out-of-pocket expenditure, and even reluctance amongst neurologists towards referring for advanced treatments. Another considerable concern is the lack of standardized training guidelines for EVT from the region.[3] International HIC guidelines serve as a model for reference; however, no measures exist to ensure consistent adherence. In addition, peculiarities of stroke unique to this population direct that tailored, region-specific guidelines should be developed and implemented.

Healthcare systems and their coverage in SEAR

Healthcare systems in the SEAR are highly diverse, with a complex mix of public and private delivery ranging from government insurance to high out-of-pocket financing. Countries like Thailand and Singapore have predominantly public health coverage. Since 2002 when Thailand endorsed Universal Health Coverage (UHC), stroke has been covered under public health, but the rate of thrombolysis use (0.18–8.04%) remains limited.[27] Bhutan also provides UHC for its citizens. However, most other countries in the SEAR do not have UHC, and therefore, despite the availability of advanced medical technology, poor affordability limits its equitable usage. Increasing education levels and the rising demand for high-quality healthcare have resulted in a push toward privatization in most countries. India has a 3-tier healthcare model with primary, secondary, and tertiary level hospitals.[8] The predominant private healthcare provision, lack of social insurance, and large urban-rural divide result in wide heterogeneity in the accessibility and affordability of physicians and facilities across different regions. Likewise, Nepal is highly reliant on out-of-pocket financing for its healthcare. Although the health sector has gained policy priority, the per capita public investment for health is below US$20, and over two-thirds of hospital beds are in private facilities.[28] LMICs like Indonesia, have exercised complete decentralization of their healthcare systems, i.e., devolution to district/local governments since 2001. These shifts in the health system have placed pressure on the public sector to adapt, evolve, and provide.[29] With the crucial demand to restructure healthcare delivery and financing, many innovative financing schemes have been implemented throughout the region. The Ayushman Bharat Yojana and the PM-JAY scheme in India is one of the biggest government-funded programs to provide comprehensive healthcare services, with secondary and tertiary healthcare insurance for patients, including stroke, with access to IVT, EVT, and SU care.

Telestroke care

The revolution of mobile phone technology in many of the SEAR countries is being tapped into to provide stroke care. This is especially seen in India with the advent of numerous trials on app-based and technology-based low-cost telestroke models of care. In a trial in North India, a smartphone-based hub and spoke telestroke model (2 tertiary hospitals as a hub and 17 district hospitals as spokes) successfully thrombolysed 26 patients at 9 district hospitals without the onsite presence of a neurologist.[30] Indonesia and Nepal have also recognized the value of telestroke care, especially considering the difficult terrain in these regions.[31,32]

Rehabilitation and community reintegration

Post-stroke rehabilitation across SEAR is reported to be poorly implemented due to various barriers. With priority given to acute care, the emphasis on rehabilitation in SEAR has been neglected.[33] SEAR contributes to a considerable proportion of Years Lived with Disability due to stroke.[34] Some factors that amplify this burden are unique to this subcontinent. In Sri Lanka, for example, the follow-up is inadequate and disproportional, with men receiving a higher percentage of services. Additionally, their national policy lacks regulations for home-based care and services for economically vulnerable populations.[35] In Bangladesh, rehab services are provided predominantly by the private sector, making it economically unaffordable for the general population, a picture like India.[36,37] In Thailand, there is a wide variation in those receiving post-stroke rehab across all phases. While most receive physiotherapy, the other disciplines of rehab are poorly available. The village health volunteers mainly provide rehab services in the community and mid-level centers.[38] It is essential for the rehab workforce to coordinate with each other and with other stakeholders and policymakers.[39]

Another challenge is the unavailability of training for rehabilitation professionals in countries such as Bhutan, driving those interested to seek training elsewhere. Limited professional training opportunities, insufficiently trained staff, lack of standardized care across countries, and underemployed rehab professionals are the main concerns for the rehab workforce for stroke.[33] Not only are the numbers of Physiotherapists (PTs), Occupational Therapists (OTs), Speech-language therapists (SLTs), and others from multidisciplinary teams inadequate, but evidence raises the need for continued education. Limited skilled staff leads to poor user awareness of stroke, its causes, prevention, rehab, and secondary prevention.[33]

Out-of-pocket expense of stroke rehab in these countries further deter patients and instead contribute

Countries	Population (in million)	Acute stroke care	Healthcare systems and UHC	EMS systems	Neurologists[a]	SUs	IVT capable centers	EVT capable centers	PTs[a,49]	OTs[a,49]	SLPs[a,49]
Bangladesh	160	Low utilization of IVT	No UHC, affordability issues	Inadequate	160	N/A	20	1	920	176[50]	200
Bhutan	0.79	Limited acute care units	UHC	Inadequate	0	2	1	0	48	N/A	2
India	1400	Low utilization of IVT	Public and private healthcare	Inadequate	2500[51]	400[a]	595	365	14,735	6000[52]	1700
Indonesia	282	Low utilization of IVT	Decentralized healthcare system	Inadequate	1200[31]	40	1000[a]	5432	5615	2000[53]	N/A
Maldives	0.56	Low utilization of IVT, limited availability of stroke services	Public healthcare	Robust referral system	9	2	3	1	33	N/A	6
Myan mar	54.1	Low utilization of IVT, limited availability of stroke services	Public healthcare	Inadequate	56	11	11	0	1442	N/A	1
Nepal	29.1	Low utilization of IVT	No UHC, heterogenous health coverage	Inadequate	34[54]	4	15	3	1200[55]	13[55]	92[56]
Sri Lanka	21.6	Low utilization of IVTPA	Public and private healthcare system, UHC	Inadequate	53	9	31[57]	2	1000	160	200[a]
Timor Leste	1.3	N/A	N/A	N/A	2	N/A	N/A	0	2	N/A	N/A
Thailand	70	Challenges in EVT	Shifting towards private-dominated healthcare	Better structured, underutilized.	824	116	212	46	8000	1674	118[58]

[a]The data illustrated is a consolidation of and approximated information from published literature and communications from experts in the countries. The workforce represents general neurology healthcare professionals including stroke care, however, is not a depiction of specialist stroke professionals alone.

Table 1: **Current stroke systems and gaps in stroke care in the SEAR Countries.**

to increased stress and poor quality of life.[40] Despite poor evidence, the deep-seated belief in traditional medicine results in stroke patients seeking rehab through approaches like acupressure, massage, herbs, Ayurveda, homeopathy, and Islamic medicine, often leading to delayed onset and, in many cases, no usage at all of post-stroke rehab.[41,42]

Stroke rehabilitation research is another area of need. It is essential to improve the quality of research output from SEAR on stroke rehab, especially concerning study designs, methodological quality, evaluation of cost-effectiveness, evaluation of integration level among the professionals, and effectiveness of home-based programs.[19,43] Bettger JP et al. have reported various emerging areas of stroke rehabilitation research that need to be focused on. Studies with a strong methodology on home/community-based rehab, multidisciplinary stroke teams, integrated care pathways, community health-worker models, caregiver level and dose of engagement, digital health technologies, and clinical practice guidelines are a few areas that have been reported to be useful.[44,45]

Secondary prevention of stroke

Secondary preventive therapies are often neglected in LMICs. The PURE (Socioeconomic factors and use of secondary preventive therapies for cardiovascular diseases in South Asia) study in South Asia reported an 80% lack of medication adherence. This could be attributed to underutilization of healthcare services and reduced access to curative care, which are compounded by low household wealth index and illiteracy.[46] Various contextual strategies have been adopted by some of the SEAR countries, including community empowerment, task shifting, polypill strategy, mobile technology (mHealth) use. A cluster randomized trial evaluated task shifting among community health workers/ASHAs (Accredited social health activists) for Secondary Prevention of Stroke in Rural populations (ASSIST study) in India, with 95% medication adherence, 25% increase in exercise, and improved systolic blood pressure control in 69% stroke patients.[47] A digital and print model of patient education and awareness intervention for secondary stroke prevention, the SPRINT (Secondary prevention with a structured semi-interactive stroke prevention package in INDIA) trial resulted in 94% medication adherence, 85% alcohol cessation, and 83% smoking cessation.[48] A multiprong approach is needed to prevent recurrent strokes in SEAR.

The available data, although limited, portrays the existing condition of stroke services and the numerous challenges to the implementation of stroke care across the continuum, including pre-hospital, acute stroke, and rehabilitation in the SEAR (Table 1).

The WHO-SEARO program and implementation

The NCD Regional Action for Southeast Asia 2013–2020 aims for a premature mortality reduction of 25% by 2025 to reduce Non-Communicable Diseases (NCDs), including strokes. Stroke prevention, management, and rehabilitative support is an important strategy to achieve this commitment. The World Health Organization (WHO) must provide technical support to Member States for various NCD services, including stroke. Stroke care linked to PEN services as a continuum of care is a crucial work stream (Fig. 1).[59]

In 2020, four SEAR countries, Bhutan, Myanmar, Maldives, and Timor-Leste, expressed their need for

technical support from WHO to improve stroke care services. This marked the beginning of a collaboration between WHO-SEAR and the Christian Medical College (CMC) in Ludhiana, Punjab, India, to extend technical support in these countries to improve stroke care programs. The specific objectives of this program included:

1. Designing a service delivery model to improve stroke care contextualized to country situations.
2. Developing the capacity of the health workforce for providing stroke care services (acute care to rehabilitation).
3. Establishing a stroke registry for surveillance and monitoring stroke outcome.
4. Improving access to public information and education for recognition and early warning signs of stroke.

Given the improvement in the stroke care continuum in the target countries, the project was expanded in May 2021 to involve two more countries: Nepal and Sri Lanka. Furthermore, with assistance from WHO Geneva, an implementation research project on evidence-based stroke interventions in Bhutan has been initiated. Elaborate Country stories for Bhutan and Nepal have been illustrated in the panel, and Maldives, Myanmar, Timor Leste, and Sri Lanka have been described in the Table 2 and Figs. 2–4.

Pragmatic solutions to improve stroke care services in SEAR

The stroke care services in SEAR countries urgently need to be strengthened and improved. Most data in our evidence-based repository comes from HICs, but when trying to replicate those practices, we must be aware of these nations' geographical, cultural, social, and economic disparities. The Global Stroke Action Plan of the World Stroke Organization suggests setting realistic goals and context-appropriate targets while acknowledging the need to consider the diversity of stroke care systems worldwide.

Effective primary prevention and reduction in treatment delays depend on raising public knowledge of stroke and its risk factors. Applying behavioral modification programs and governmental policies such as taxes on high-risk behavior is essential to control lifestyle determinants.[74] Increasing social literacy on stroke through wide dissemination of FAST and BEFAST programs, specialized stroke recognition training for paramedical staff, creating a national stroke hotline number to expedite referrals, and adopting hospital prenotification are steps to establish better stroke care systems.

Costly interventions like IVT and EVT may not be accessible and affordable for all in these resource-strained countries. Cost-effective interventions like

Bhutan

Bhutan has a three-tiered government health system, including the Jigme Dorji Wangchuck National Referral Hospital (JDWNRH) at the tertiary level, and two regional referral hospitals, followed by secondary and primary level hospitals.[69] Based on the GBD 2019, stroke is the third main cause of death in Bhutan. With no primary or comprehensive stroke centers, no neurologists, and poor awareness of stroke, there is a lack of effective stroke care in Bhutan.[70]

Phase 1 of the WHO-SEAR project was completed in April 2021, training and certifying >50 healthcare professionals in evidence-based stroke care. The first IVT was done in 2022, followed by the implementation of a well-defined stroke pathway, and the establishment of stroke units in two hospitals. The CMCL team visited the Kingdom of Bhutan in May 2023 to oversee stroke care services and advocated for future improvements in stroke care with different stakeholders in the country, in addition to an audience with Her Majesty the Queen Mother Sangay Choden Wangchuck, UNFPA Goodwill Ambassador who has been a dedicated supporter for improving stroke care services. In further collaboration with WHO Geneva, an implementation research project "Bhutan's Response Against Increasing Number of Stroke (BRAINS)" is currently underway to assess a physician-led model of stroke care[71] (Fig. 2).

Nepal

The Human Development Index places Nepal among the least developed nations, giving it one of the lowest rankings.[72] Stroke accounted for 7.2% of all deaths in 2019. However, with only about 35 neurologists and a limited number of PTs and OTs for a population of approximately 30 million, stroke care in the country is far from optimal. Poor awareness, lack of essential medicines, privatization of the health sector, and limited affordability are the main challenges faced. Outside of Kathmandu, IVT facilities are available in only 3 hospitals sparingly, while EVT is limited to Kathmandu.[73]

A critical evaluation was carried out under the WHO-SEARO-CMCL collaboration from May to August 2021 through discussions with the Nepal Stroke Association. Supported by the WHO country office, in partnership with experts from the University of Heidelberg and Angels Initiative, the Nepal Stroke Project has been initiated to develop stroke-ready hospitals across the country via a hub-and-spoke model approach. With a focus on areas that have potential for improvement, the stroke appraisal seeks to supplement the ongoing efforts. The following phases involve increasing the capacity of tertiary care hospitals, creating networks with secondary and primary healthcare providers, developing rehabilitation, and advancing stroke research (Fig. 4).

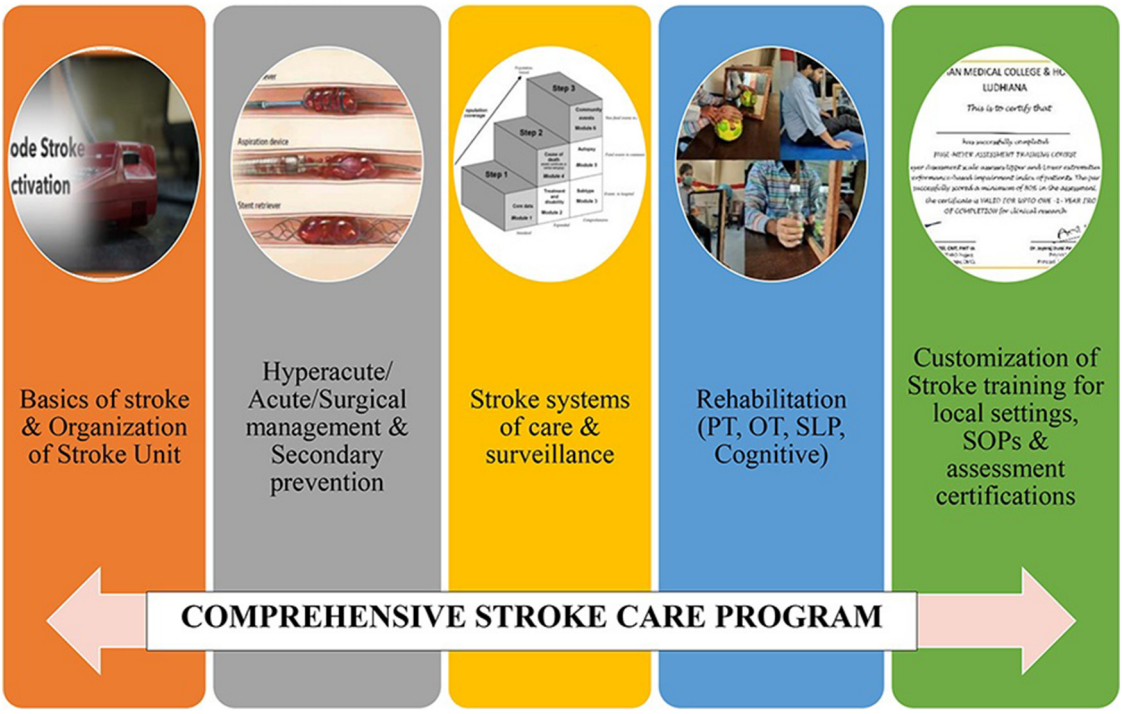
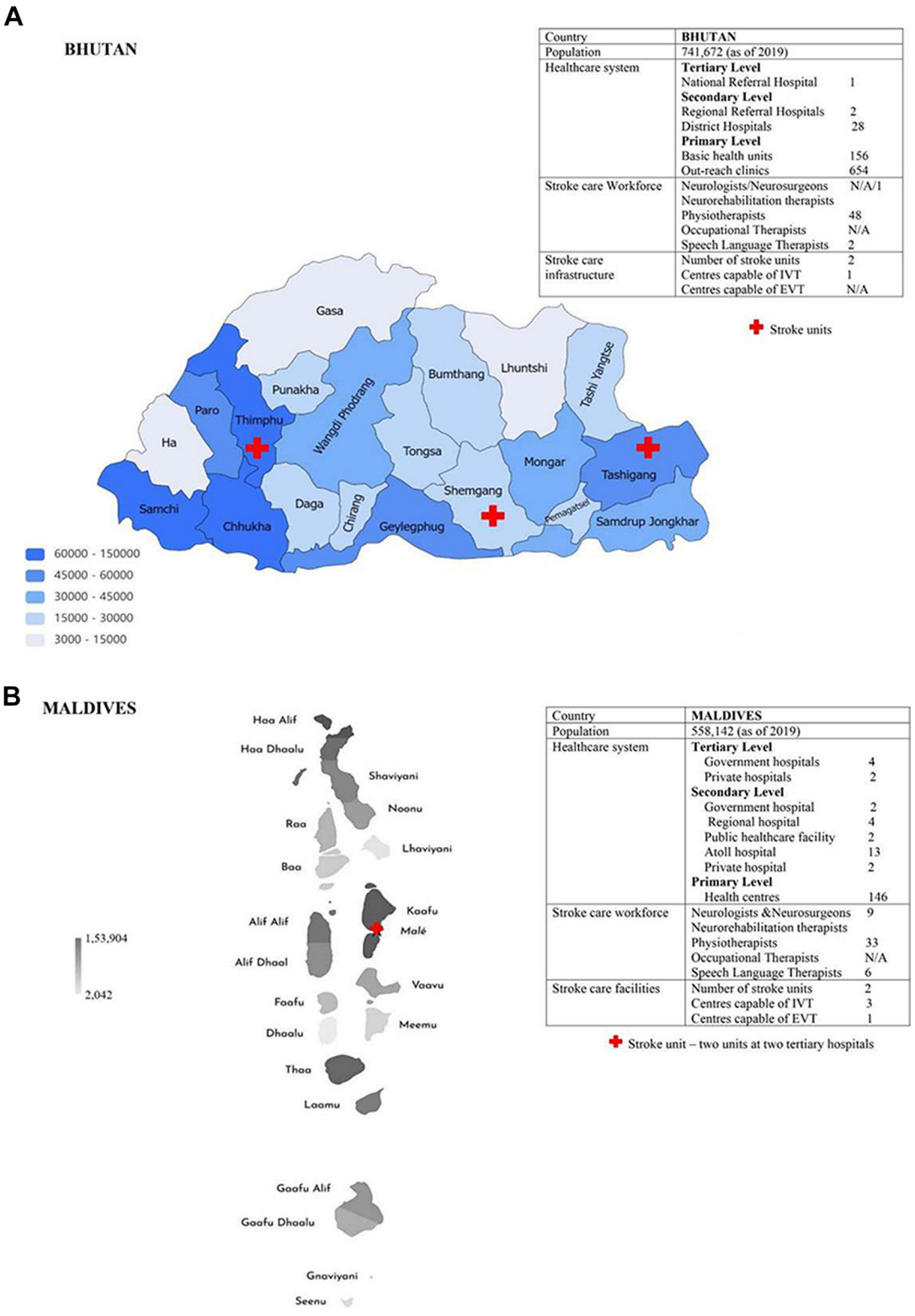


Fig. 1: **Evidence-based and peer-reviewed training modules for Stroke care developed by WHO-SEARO-CMCL Collaboration.**

stroke units, adoption of care protocols such as FeSS protocol, bowel/bladder care, and early mobilization can help offset mortality and morbidity. Alternative models of stroke care, such as the hub-and-spoke, task-sharing, and physician-led models, are effective models that should be implemented in countries with inadequate trained personnel.[19] Tele-stroke networks, digital technology, and mobile apps can be leveraged within and

Country	Country stories
Maldives	An archipelagic country located in the Indian Ocean,[60] the Republic of Maldives has a 3-tier healthcare model with primary health centers, secondary atoll hospitals, and tertiary regional hospitals. Maldives benefits from a robust referral system with the national ambulance, air ambulance (Medical Air Service), sea ambulance services, and a national hotline number 1676 or 100 in the country. IVT is available in 3 centers in the country while EVT is provided only in 1 center. Considering the topographical challenges, while utilizing the advantage of a well-established referral system, a hub-and-spoke model of stroke care was devised for the country. Stroke education training was conducted at Indira Gandhi Memorial Hospital planned as the hub hospital with regional hospitals across the islands as spoke hospitals. The training was completed by 19 healthcare professionals. Apart from medical and rehabilitation modules, 1 virtual EVT training session was also conducted at the hub hospital. Future steps include additional training workshops and establishing a stroke registry (Fig. 2).
Myanmar	Stroke comprises 20% of the neurological workload in Myanmar and is the leading cause of morbidity and death.[61] The health system supported by the Ministry of Health comprises state, district, and township health departments. The national health coverage remains below the target rate of 80%, and the financing is largely out-of-pocket.[62] There are 56 neurologists and 27 neurosurgeons in the country but stroke patients are also managed by general physicians in secondary hospitals.[63] Although thrombolysis is currently offered in 11 hospitals, EVT is unavailable.[63] Since the launch of the National strategic rehabilitation plan, post-stroke rehabilitation has steadily improved, however, a lack of OTs and SLTs remains.[64] The WHO-SEARO-CMCL project undertook to strengthen and improve the existing systems within the country with a standardized capacity-building program to develop evidence-based stroke-care protocols, strengthen the rehabilitation workforce, and establish a stroke registry. However, the project was held off in the face of the difficulties faced with the political unrest and humanitarian aid delivery access (Fig. 3).
Timor Leste	Another small island nation in the SEAR is Timor-Leste with a population of 1.3 million.[65] Accounting for 13% of total deaths in 2020, stroke is the leading cause of mortality. There is a lack of trained stroke care professionals with only 2 neurologists and 2 PTs. Capacity building was initiated for medical teams at the Guido Valadares National Hospital in evidence-based stroke care practices, and to facilitate the establishment of a stroke registry. Additionally, technical advisory to facilitate the establishment of a stroke unit was also suggested (Fig. 3).
Sri Lanka	Stroke is the sixth leading cause of death and the fifth leading cause of Disability Adjusted Life Years (DALYs) in Sri Lanka.[17] Sri Lanka benefits from a robust healthcare system with both public and private sectors and Universal Health Coverage.[66] Although stroke care in Sri Lanka has been evolving through the joint efforts of the government and the stakeholders, there are inadequate numbers of neurologists and trained stroke nurses.[67] With fewer than 100 available stroke beds nationwide, only 2 EVT-ready centers, and insufficient allied health force, there are many gaps to be addressed.[67,68] Under the WHO-SEARO project, multiple discussions with leading experts of the country and the National Stroke Association of Sri Lanka were held to prepare a stroke appraisal document highlighting the current stroke systems of care and the gaps, with key recommendations focusing on potential areas of improvement. A multipronged approach with the integration of stroke care into the health care pathway, a structured referral system from primary to tertiary levels, and establishing a population-based stroke registry are some of the main targets considered (Fig. 4).

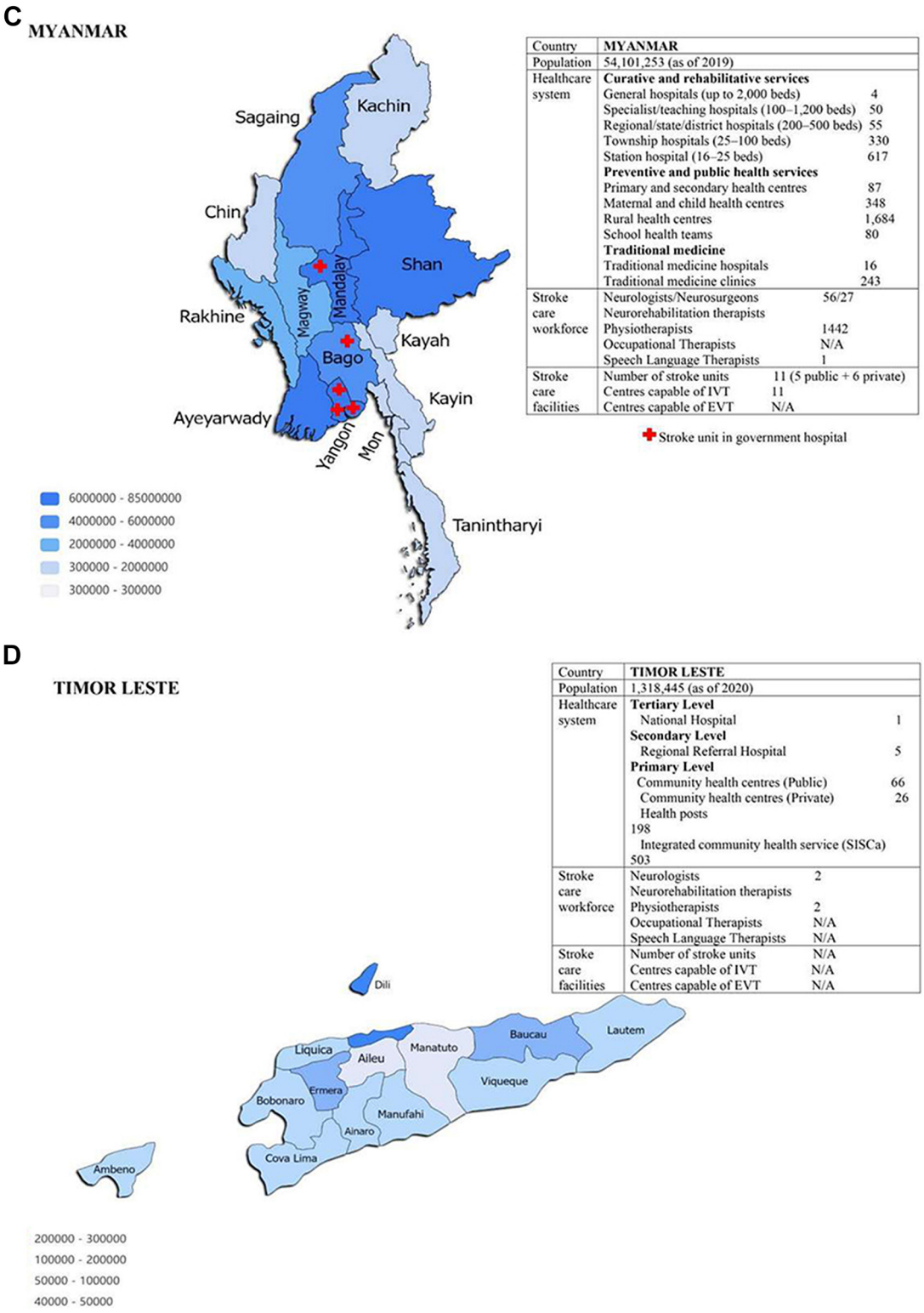
Table 2: **Country stories for Maldives, Myanmar, Timor Leste and Sri Lanka.**



Country	BHUTAN	
Population	741,672 (as of 2019)	
Healthcare system	**Tertiary Level**	
	National Referral Hospital	1
	Secondary Level	
	Regional Referral Hospitals	2
	District Hospitals	28
	Primary Level	
	Basic health units	156
	Out-reach clinics	654
Stroke care Workforce	Neurologists/Neurosurgeons	N/A/1
	Neurorehabilitation therapists	
	Physiotherapists	48
	Occupational Therapists	N/A
	Speech Language Therapists	2
Stroke care infrastructure	Number of stroke units	2
	Centres capable of IVT	1
	Centres capable of EVT	N/A

Country	MALDIVES	
Population	558,142 (as of 2019)	
Healthcare system	**Tertiary Level**	
	Government hospitals	4
	Private hospitals	2
	Secondary Level	
	Government hospital	2
	Regional hospital	4
	Public healthcare facility	2
	Atoll hospital	13
	Private hospital	2
	Primary Level	
	Health centres	146
Stroke care workforce	Neurologists &Neurosurgeons	9
	Neurorehabilitation therapists	
	Physiotherapists	33
	Occupational Therapists	N/A
	Speech Language Therapists	6
Stroke care facilities	Number of stroke units	2
	Centres capable of IVT	3
	Centres capable of EVT	1

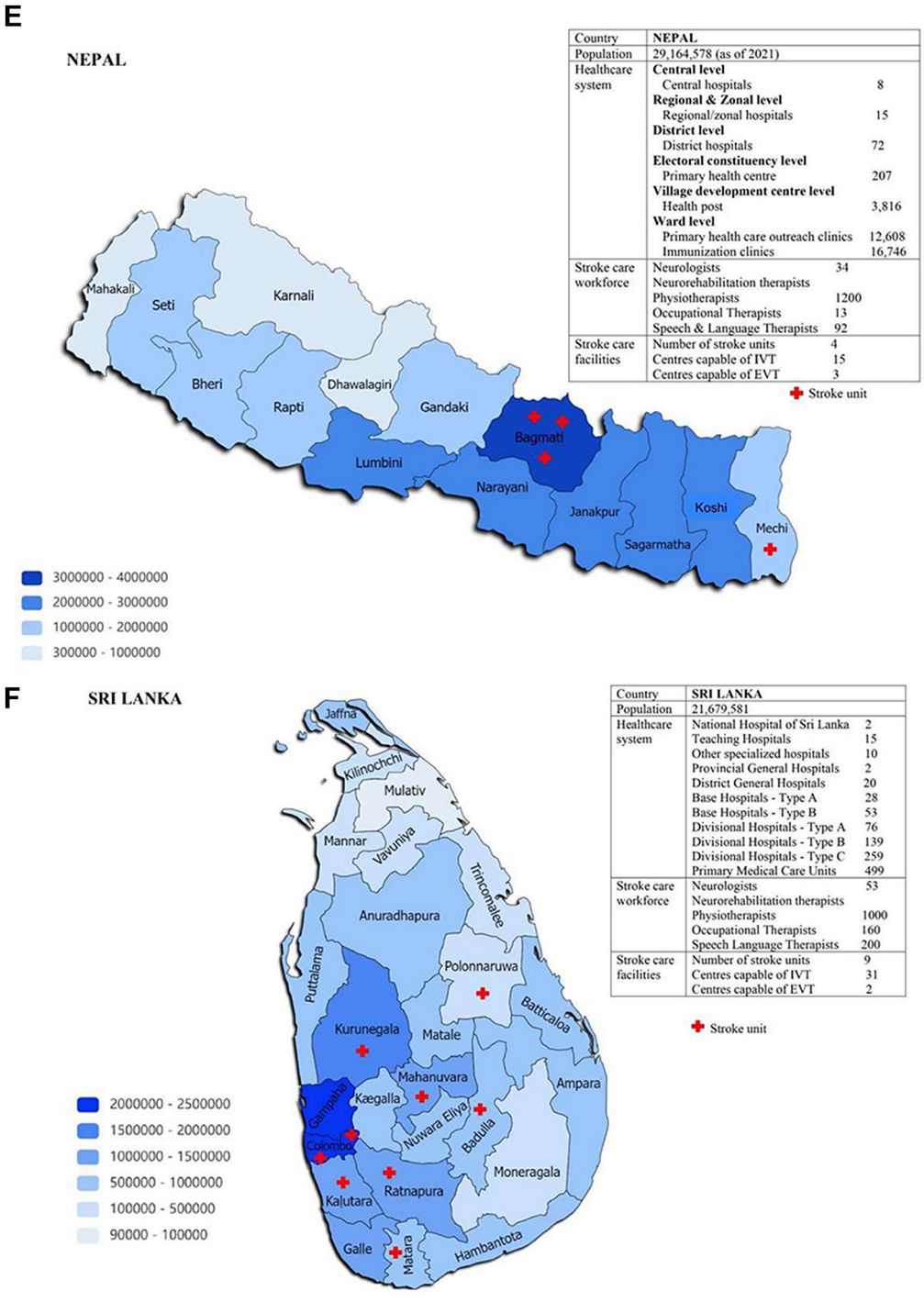
Fig. 2: **Population maps of Bhutan and Maldives illustrating existing systems of care across the stroke care continuum.**



Country	MYANMAR	
Population	54,101,253 (as of 2019)	
Healthcare system	**Curative and rehabilitative services**	
	General hospitals (up to 2,000 beds)	4
	Specialist/teaching hospitals (100–1,200 beds)	50
	Regional/state/district hospitals (200–500 beds)	55
	Township hospitals (25–100 beds)	330
	Station hospital (16–25 beds)	617
	Preventive and public health services	
	Primary and secondary health centres	87
	Maternal and child health centres	348
	Rural health centres	1,684
	School health teams	80
	Traditional medicine	
	Traditional medicine hospitals	16
	Traditional medicine clinics	243
Stroke care workforce	Neurologists/Neurosurgeons	56/27
	Neurorehabilitation therapists	
	Physiotherapists	1442
	Occupational Therapists	N/A
	Speech Language Therapists	1
Stroke care facilities	Number of stroke units	11 (5 public + 6 private)
	Centres capable of IVT	11
	Centres capable of EVT	N/A

Country	TIMOR LESTE	
Population	1,318,445 (as of 2020)	
Healthcare system	**Tertiary Level**	
	National Hospital	1
	Secondary Level	
	Regional Referral Hospital	5
	Primary Level	
	Community health centres (Public)	66
	Community health centres (Private)	26
	Health posts	198
	Integrated community health service (SISCa)	503
Stroke care workforce	Neurologists	2
	Neurorehabilitation therapists	
	Physiotherapists	2
	Occupational Therapists	N/A
	Speech Language Therapists	N/A
Stroke care facilities	Number of stroke units	N/A
	Centres capable of IVT	N/A
	Centres capable of EVT	N/A

Fig. 3: Population maps of Myanmar and Timor Leste illustrating existing systems of care across the stroke care continuum.



Country	NEPAL	
Population	29,164,578 (as of 2021)	
Healthcare system	**Central level**	
	Central hospitals	8
	Regional & Zonal level	
	Regional/zonal hospitals	15
	District level	
	District hospitals	72
	Electoral constituency level	
	Primary health centre	207
	Village development centre level	
	Health post	3,816
	Ward level	
	Primary health care outreach clinics	12,608
	Immunization clinics	16,746
Stroke care workforce	Neurologists	34
	Neurorehabilitation therapists	
	Physiotherapists	1200
	Occupational Therapists	13
	Speech & Language Therapists	92
Stroke care facilities	Number of stroke units	4
	Centres capable of IVT	15
	Centres capable of EVT	3

✚ Stroke unit

Country	SRI LANKA	
Population	21,679,581	
Healthcare system	National Hospital of Sri Lanka	2
	Teaching Hospitals	15
	Other specialized hospitals	10
	Provincial General Hospitals	2
	District General Hospitals	20
	Base Hospitals - Type A	28
	Base Hospitals - Type B	53
	Divisional Hospitals - Type A	76
	Divisional Hospitals - Type B	139
	Divisional Hospitals - Type C	259
	Primary Medical Care Units	499
Stroke care workforce	Neurologists	53
	Neurorehabilitation therapists	
	Physiotherapists	1000
	Occupational Therapists	160
	Speech Language Therapists	200
Stroke care facilities	Number of stroke units	9
	Centres capable of IVT	31
	Centres capable of EVT	2

✚ Stroke unit

Fig. 4: **Population maps of Nepal and Sri Lanka illustrating existing systems of care across the stroke care continuum.**

Search strategy and selection criteria

Literature searches were conducted in PubMed, Web of Science and Google Scholar databases for articles published between December 1, 2000 and December 31, 2022 describing current stroke services and systems of care, challenges to delivery and implementation of stroke care and pragmatic solutions to improved stroke care with a focus on SEAR countries. We used the search terms Stroke along with the Boolean operator AND with one of the following terms: "stroke care systems", "stroke services", Pre-hospital stroke care", "Emergency care", "Stroke unit care", "Tissue plasminogen activator", "Thrombolysis", "Secondary prevention", "Rehabilitation", "Physiotherapy", "stroke rehabilitation". The search was restricted to South-East Asian region countries by using the Boolean operator AND with one of the following search terms: "South-east Asia region", "SEAR", "India", "Nepal", "Bangladesh", "Sri Lanka", "Bhutan", "Maldives", "Indonesia", "Thailand", "Timor Leste", "North Korea", "Myanmar". Articles other than reviews or original research and published in English language were excluded. Additional studies were identified through other sources including experts working in these countries and a hand search of search engines. A total of 2852 articles were identified of which 180 met the screening criteria. Among these, 34 articles provided information on existing stroke systems of care, the challenges, and potential strategies to improve stroke care in SEAR countries, and these were included in the final analysis.

across countries for knowledge sharing. An example of mHealth strategy to increase non-specialists' capacity to provide stroke care is the ENIGMA (ENhancing Stroke Care Interventions for Global Medical Assistance) app.[75] The development of nationally standardized training programs for stroke professionals and standardized clinical practice guidelines for stroke and post-stroke rehabilitation is vital. Conscious of this need, the Global Consortium for Stroke Rehabilitation in Low- and Middle-income countries is an initiative to develop LMIC-specific CPGs for stroke rehabilitation. Lastly, integrating stroke care into national healthcare programs is essential to achieve sustainable goals in stroke care. Stroke care performance measures should be integrated as health service indicators.

Conclusion

Stroke care in the SEAR has consistently improved over the years. Despite the challenges, the region has witnessed advances in stroke care facilities across the continuum of care. Alternative models of stroke care, infrastructural reorganization, capacity building, and integration of stroke care in the national NCD program are the ways to improve stroke care services. It is important to allow realistic expectations while considering economic barriers and local governmental policies. Evidence-driven policymaking by adopting a holistic approach with the active involvement of stakeholders, healthcare policymakers, government agencies, and ministries of health is essential to breaking ground towards achieving equitable stroke care in the SEAR.

Contributors

IAS, JDP conceptualized the review; DBCG, RJI, PJV, and NSC conducted the literature search, data collection, and analysis; IAS supervised data collection compiled, and wrote the first draft of the manuscript; PNS, RP, YVK, YY, HG, SO, KMH, TT, JDP revised the draft critically for important intellectual content. All authors have read and approved the final version of the manuscript.

Editor note

The Lancet Group takes a neutral position with respect to territorial claims in published maps and institutional affiliations.

Declaration of interests

The authors declare no competing interests.

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