The state of stroke services across the globe: Report of World Stroke Organization–World Health Organization surveys

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Abstract

Background: Improving stroke services is critical for reducing the global stroke burden. The World Stroke Organization–World Health Organization–*Lancet Neurology* Commission on Stroke conducted a survey of the status of stroke services in low and middle-income countries (LMICs) compared to high-income countries.

Methods: Using a validated World Stroke Organization comprehensive questionnaire, we collected and compared data on stroke services along four pillars of the stroke quadrangle (surveillance, prevention, acute stroke, and rehabilitation) in 84 countries across World Health Organization regions and economic strata. The World Health Organization also conducted a survey of non-communicable diseases in 194 countries in 2019.

Results: Fewer surveillance activities (including presence of registries, presence of recent risk factors surveys, and participation in research) were reported in low-income countries than high-income countries. The overall global score for prevention was 40.2%. Stroke units were present in 91% of high-income countries in contrast to 18% of low-income countries (p < 0.001). Acute stroke treatments were offered in ~60% of high-income countries compared to 26% of low-income countries (p = 0.009). Compared to high-income countries, LMICs provided less rehabilitation services including in-patient rehabilitation, home assessment, community rehabilitation, education, early hospital discharge program, and presence of rehabilitation protocol.

Conclusions: There is an urgent need to improve access to stroke units and services globally especially in LMICs. Countries with less stroke services can adapt strategies from those with better services. This could include establishment of a framework for regular monitoring of stroke burden and services, implementation of integrated prevention activities and essential acute stroke care services, and provision of interdisciplinary care for stroke rehabilitation.

Keywords

Stroke services; high-income countries; low- and middle-income countries; prevention; stroke quadrangle; acute care; rehabilitation

Introduction

The burden of stroke remains a huge public health concern. In 2019, stroke was the second leading cause of death and disability worldwide.[1–3] Over the past five decades (from 1970 to 2019), in absolute terms, stroke incidence, prevalence, mortality, and disability adjusted life

years increased at a much greater pace in low- and middle-income countries (LMICs) than in high-income countries (HICs).[1,4,5]

The enormous burden of stroke presents several challenges. First, although LMICs[6,7] bear most of the burden, they have only a small part of the global financial and health-care resources to combat it. Over 90% of the poorest billion live in LICs and lower-MICs.[8] Second, despite the current available knowledge of evidence-based interventions for stroke prevention and treatment, this has not translated to reduce stroke burden in LMICs due to barriers limiting implementation.[9]

The *Lancet Neurology* Commission on Stroke is a collaboration with the World Health Organization (WHO) and the World Stroke Organization (WSO)[10] to tackle the global burden of stroke with focus on LMICs. This Commission aims to provide evidence-based pragmatic solutions leading to the reduction of the global burden of stroke including its incidence, prevalence, death, and disability especially in LMICs which bear the brunt of the epidemic. To enable us identify facilitators and barriers and derive such solutions, we first conducted a situational evaluation of the state of stroke-related services and resources in LMICs compared to HICs.

Methods

Survey objective and survey instrument

We sought to determine the state of stroke-related services across countries. The survey was developed by a team within the WSO. Details of the survey tool development, content, and content validation are provided in the Supplementary Methods.

Survey setting, participants sampling, and eligibility

Commissioners, identified through our networks (including Global Burden of Diseases (GBD) and WSO networks), were invited from each country based on the eligibility criteria in Supplementary Table 1 as partners in a global Stroke Control, Observatory, and Reduction Ecosystem (Supplementary Figure 1) to provide data and coordinate stroke control efforts in their countries. Purposive sampling (expert sampling technique) was used to identify eligible participants (commissioners) who could provide the information required in line with the objective of the survey. This sampling technique was chosen since expertise and interest in the field of stroke was a required characteristic of each respondent (the commissioners). A pre-sampling criterion for commissioner(s) selection from each country was designed to ensure homogenous sampling procedure for all country representatives included to enable comparison of results across countries. To mitigate researcher bias, the selection criteria were transparently implemented through the Steering Committee of the *Lancet Neurology* Commission which had adequate representation of all WHO world regions.

Sampling, data collection

We sought to include all countries in which there were eligible respondents. However, through the WSO and GBD networks, contact information for eligible commissioners was only available from 89 countries. Commissioners were sent URL links to the survey by

email and completed the survey between 1 October 2017 and 1 May 2018. In preparation for the internal quality control of the survey results, commissioners were "blinded" to each other's responses. They were required to provide responses only to the questions to which they were sure of the answers and leave other items blank to avoid misleading responses.

In addition, results from the survey were compared with the 2019 WHO survey of 194 countries on non-communicable disease and data obtained from the Registry of Stroke Care Quality focused on acute treatment in 61 European countries for 2019. (Please see details of Data Collection in Supplementary Methods.)

Data analysis

Data analysis was carried out using Stata version 15.0. Data were checked, and maps were produced using R version 3.5.2. Results were grouped under the four pillars of the stroke quadrangle namely: surveillance (five items), primary and secondary prevention (17 items), acute stroke diagnostic and care facilities (104 items), and stroke rehabilitation (15 items). Domain scores were generated as simple average score of items tapping similar aspects of stroke care under a specific pillar. Pillar scores were generated by simple averages of all domain scores under each pillar. Mean domain and pillar scores were calculated by individual country. For quantitative items in the questionnaire (Appendix 2), scores were categorized into six levels: 75%, 50–<75%, 30–<50%, >0–<30%, 0%, and "no data provided" and color-coded into maps. We also evaluated the availability of acute stroke services based on the WSO roadmap classification[11] according to the local resources, professionals, and protocols implemented. From all recommended resources in each category, we used a minimum requirement to classify the hospitals into each category (Supplementary Table 2).

See Supplementary Methods for further details on data analyses and steps taken to maximize data quality. Interactive maps of the country scores can be viewed at gntem2.github.io/CommissionOnStroke/, and the codes are available at github.com/GNtem2/CommissionOnStroke/.

Results

The overall response rate for the survey was 92% with 84 of the 89 countries approached responding (34 countries from HICs, 23 from upper-MIC, 21 from lower-MICs, and 6 from LICs). All those who did not respond were from HIC, with Switzerland, Brunei, Finland, Spain, and The Netherlands not responding. From these 84 countries, 322 health professionals involved in stroke services from 261 hospitals completed the survey questionnaire.

Stroke surveillance

Overview.—In our survey, and according to average responses within each country, only 26 (32%) countries scored between 50 and <75% for stroke surveillance (for the combination of the three domains regarding availability of registries, participation in stroke research, and active or recently completed risk factor surveys; see Appendices 2 and 3 and Supplementary Table 3), with 34 (43.6%) countries scoring between 30 and 50%), while 6 (7.7%) countries

scored >0 but <30%. Respondents in seven (9.0%) countries (Albania, Bangladesh, Bolivia, Pakistan, Papua New Guinea, Seychelles, and Uganda) declared having no surveillance measures in place (scores of 0%; Figure 1, Supplementary Table 3). In contrast, in only six countries (Norway, Slovakia, Poland, Denmark, Germany, and France) was surveillance scored 75% or above. Participants from six (7.9%) countries provided no details for the presence or absence of stroke registries, risk factor surveys, or research for stroke (Supplementary Table 3).

While more than 50% of commissioners in each country income category reported participation in stroke research (including population-based and clinical research; Supplementary Table 4), the greatest barrier to achieving a score for surveillance of at least 50% for the three domains of availability of registries, participation in stroke research, and active or recently completed risk factor surveys was the reported lack of an active or recent (within the last five years, i.e. after 2013) risk factor survey (Supplementary Table 5). Some responders in low-income countries appeared to be actively engaged in stroke research; although it is possible that the who responded to this question came from higher-performing hospitals than those who did not respond. Overall, 61 commissioners (18.9%) who participated in the survey did not respond to any of the questions on stroke surveillance, so those who responded may not be representative of their entire countries and regions.

Commissioners from 60 of the 78 countries (77%) reported the presence of stroke registries (Supplementary Table 5). However, responses from only 14 (18%) of these countries equated to a score of 100%, indicating that these registries were nation-wide. While many of the countries had some registries in place, most appeared to be conducted within single hospital settings and so were not nationally representative. Because single hospitals vary in the facilities available and the types of patients admitted, for example, people with mild stroke, these single hospitals could provide a skewed picture of the burden of stroke and its treatment in their country.

Relation to country income level.—Overall, the scores for surveillance were greater with each increasing level of income, as measured against the World Bank's 2019 country income classification (Supplementary Table 4); 23.1% on average for 13 responses from 4 low-income countries, 36.5% for 52 responses from 21 lower-middle-income countries, 40.5% for 94 responses from 23 upper-middle-income countries, and 52.7% for 102 responses from 34 high-income countries.

Stroke prevention

Overview.—The overall global score for prevention was 40.2% (Table 1), indicating that concerning availability of services and activities for primary and secondary stroke prevention, only about 40% of responders replied positively to all questions. The highest scores (48.2%) were observed in the Central and Eastern Europe and Central Asia, and North Africa and Middle East (43.7%) GBD super-regions; and WHO European Region (44.4%), Western Pacific Region (42.7%), and South-East Asia Region (40.8%). The lowest scores were observed in sub-Saharan Africa GBD super-region (28.9%) and WHO Region of the Americas (34.7%) (Table 1; Supplementary Table 6).

Primary prevention.—Only about one-third of the recommended primary prevention activities were being used in the hospitals which participated in the survey. Health professionals from 34/82 countries (41%) reported low or no activity (30% score) for primary stroke prevention (Supplementary Table 7; Supplementary Table 6). These activities were particularly low in LICs, especially in the activities related to primary stroke prevention. None of the LICs had "good" (>50%) scores for primary prevention activities. While low primary prevention (<30% positive responses on the availability of primary prevention services) was observed in Czech Republic, Slovakia, United Kingdom, Japan, Argentina, Belarus, Peru, Brazil, Sri Lanka, and most sub-Saharan Africa; "very good" and "acceptable" primary prevention were observed in most European, Asian-Pacfic, and North American countries (Supplementary Table 7; Supplementary Figure 2; Figure 2; Supplementary Table 3).

Secondary prevention.—Overall, secondary stroke prevention activities were at benchmark level (score 50+) in only 40–46% of participating hospitals (Supplementary Table 6). Lowest secondary prevention activity scores were observed for routinely available education about stroke and lifestyle management for stroke patients and their families; while highest scores were reported for the use of antiplatelet, anticoagulant, blood pressure, and lipid-lowering medications. The most widely available medicines were aspirin, metformin, and thiazide diuretics (available in 90%, 87%, and 87% of countries, respectively); 92% of countries in the European Region (all but four of 53 countries) reported angiotensin II receptor blockers being generally available, but only 36% of countries in the African region reported such availability.

Of all countries which participated, hospital-based health professionals from 23/82 countries (28%) reported low or no activity (30% score) for secondary stroke prevention (Supplementary Table 6). Most countries showed "good" or "acceptable" level of secondary stroke activities (Supplementary Figure 2b). It is important to note that availability of outpatient stroke/TIA clinics or stroke prevention clinics was very good in only upper-middle- and high-income countries. Stroke prevention services were found at 30–50% in LMICs, with 50–60% prescription of antihypertensive agents for secondary stroke prevention and anticoagulant, antiplatelet, and statin agents for prevention of ischaemic stroke at discharge from hospital across countries of all levels of development. There were approximatelyfivefold more countries with a very good score for secondary prevention activities than for primary prevention activities (Supplementary Table 6).

Acute stroke care

Overview.—Results of the survey in 84 participating countries showed that most hospitals were far from offering the full range of evidence-based acute care services with an overall score for acute care services of 49% (Supplementary Table 2). Health professionals from only 50% of countries reported at least 50% of all the recommended elements for acute care, with most in HICs and upper-MICs (Figure 3, Supplementary Table 3). From 318 participating hospitals, 17.6% were Advanced, 17.3% Essential, and 68.1% Minimal (Table 2). That is, only a minority of hospitals (35% classified as Advanced or Essential) had the minimum required structure of a stroke center (Table 2).

Cranial computed tomography (CT) scan was available in 57.2%, intravenous (IV) thrombolysis in 46.5%, acute endovascular treatment in 30.5%, and neurologists for acute stroke care available 24 h a day in 37.1% of the centers that were surveyed (Supplementary Table 8a and 8b). From all hospitals with CT scan available, 79% performed a CT scan within 24 h from hospital arrival. Most hospitals were public (73%) and university teaching hospitals (77.3%), with low number of community health clinics or remote population centers (6.2%), these were only available in lower-middle-income countries and low-income countries in this study. Emergency Medical Services were available covering 55.8% of hospitals. Telemedicine for acute stroke care was available by videoconference in 15.6% of hospitals, using the recommended[12] rapid sharing of clinical and neuroimaging patient data with data protection and privacy and by phone in 39.9%. Simple, yet highly effective and low-cost patient care strategies, that could be accomplished in places without physicians, were not implemented, for example, swallowing assessment performed was performed in only 33.6% of hospitals evaluated.

Relation to country income level.—We evaluated the proportion of components available in the hospitals in relation to all recommended resources by the WSO Roadmap (Table 3). Advanced and essential services were more available in HICs and upper-MICs with a very low number of essential or advanced stroke centers in lower-MICs, and no advanced hospital documented in LICs (Table 2). In general, the "advanced" hospitals had 87.8% of the recommended structure, and "essential hospitals" had 74.3% of the recommended infrastructures. Furthermore, hospitals classified as Minimal (without reperfusion therapy) had only 21.7% of the suggested structure for the category (Table 3) consisting of general patient care (swallowing, fever, blood pressure, prevention, etc.). There were also some disparities in these resources according to income level (Table 3). HIC and upper-MIC had more stroke centers with better structure to assist stroke patients. On the other hand, these centers were less available in countries with less resources, which do not have the minimum structure, even those of low cost in their hospitals, showing great inequalities in available care.

Overall, the pillar scores for acute services and the availability of resources in acute stroke services increased with income, as measured by the World Bank's 2019 country income classification (p = 0.029; Supplementary Figure 3). The availability of stroke units was 91% in HIC and 18% in LIC (p < 0.001), and acute stroke treatments was approximately 60% in HIC and upper-MIC and only 26% in LIC (p = 0.009).

Regional differences.—The most available services were reported in Central Europe, Eastern Europe, and Central Asia (58.6%), while the least were reported in sub-Saharan Africa (29.5%), using the GBD super-region classification (Table 1). Similar distribution of scores was observed using the WHO regions, with the highest score (55%) in the European and the Western Pacific regions and the lowest score (28.7%) in the African region (Table 1).

There was lower availability of specialists in regions with lesser resources, generally regions that have a greater burden of stroke. Availability of neurologists/stroke doctors was highest in Eastern Mediterranean Region and Middle East (59%) and Central Europe, Eastern Europe, and Central Asia (56%), and lowest in sub-Saharan Africa (22%). By GBD super-

regions, we observed 56.5% for Central European, Eastern Europe, and Central Asia, 59.3% for North Africa and the Middle East, 34.8% for sub-Saharan Africa, and 18.52% for South Asia.

Additional data is provided in Supplementary Tables 9 and 10 from the Registry of Stroke Care Quality (RES-Q) 2019 survey.

Rehabilitation

Overview.—There were major gaps in the quality and quantity of rehabilitation services for stroke across countries of all income strata. Most countries had less than half of the American Heart Association recommended rehabilitation services for stroke (Supplementary Table 1, Figure 4, and Supplementary Figure 4). Compared to other stroke pillars, rehabilitation was the least available in every region in LMICs. In LMICs, availability of rehabilitation services was inadequate in required quality and quantity.

Compared to HICs, LMICs scored lower in almost all rehabilitation services – inpatient rehabilitation, home assessment, community rehabilitation, education, early hospital discharge program, and rehabilitation protocol. Furthermore, LICs and lower-MICs scored lower than upper-MICs. Based on overall responses, rehabilitation services were reported to be best in Hong Kong, Honduras, and Thailand, while Aruba, Armenia, Burkina Faso, Uganda, and Kenya reported no specfic rehabilitation services for stroke or provided no data for this pillar (Supplementary Table 1, Figure 4, Supplementary Figure 4, and Supplementary Table 11).

Relation to country income level.—In LMICs combined, overall, rehabilitation services were just over 25% of the recommended spectrum and quantity. For example, protocols for rehabilitation were not available in most LMICs, with less than a quarter of LICs having a defined protocol (Supplementary Table 12). Across country income categories, average availability of education on patient management and self-management was less than 25%. However, overall, rehabilitation services (pillar score and domain scores) were more established in HICs compared to LMICs with increasing availability with increasing income strata (Supplementary Figure 4 and Supplementary Table 12). This was statistically significant for availability of inpatient stroke rehabilitation services (Supplementary Table 12).

Regional differences.—The least available services were reported in Latin America and Carribeans (27.5%), South Asia (26.3%), and sub-Saharan Africa (29.5%) GBD super-regions (Table 1). Similar distribution of scores was observed using the WHO regions with the lowest scores in the African (24.4 %), South East Asia (28.3%), and Eastern Mediterranean regions (22.2%; Table 1).

Discussion

Stroke surveillance

Less than half of the items for the surveillance of stroke and its risk factors in the WSO Survey instrument were being collected, and this varied markedly among countries and

regions, with better scores for each increasing level of economic development. The best scores were achieved for stroke research, and the worst was for active surveillance of risk factors. There were also widespread reports of stroke registries across regions and countries, although few appeared to be national. The overall relatively high scores for undertaking stroke research may indicate that all regions were actively participating in stroke research,[13] but it is possible that the health professionals who participated in the survey were more actively involved in research than those who did not participate. Furthermore, the survey did not include any items on the quantity or quality of the research undertaken, and it is possible that these vary greatly according to the resources available and the reasons for undertaking research, for example, for the common good or for academic promotion. Thus, the scores for participation in research may overestimate both the participation in stroke research that is occurring and the quantity and quality of that research, both globally and by region.

Many of the registries reported in this survey were conducted at single sites, so while their data may be useful in prompting changes to patient care or providing new resources within their centers, their data would not be considered nationally representative and so would have limited relevance for making policy changes at a country level. The better performance among wealthier countries likely reflects the longstanding burden of chronic diseases in these regions and the potential for more resources available to them to undertake these surveillance activities. However, there were also some limitations observed in some of these data with some commissioners potentially unaware of national data in their country. Similarly, international efforts such as RES-Q and SITS-QR are available to participating hospitals at no cost as a monitoring tool for quality improvement in stroke care. As registries have been shown to result in better quality of hospital care and outcomes,[14,15] more widespread adoption of registries is recommended. This includes a national approach to surveillance that includes hospitals with minimal, essential, and advanced services, and use of web-based data entry so that clinicians or administrators can enter data when they are in the ward, in their office, or elsewhere.

The finding that there were few countries with active or recently completed risk factor surveys would be a substantial gap, as this information is essential for understanding what health promotion activities should be introduced or strengthened by any government to reduce the burden of disease from stroke and other conditions. However, only few health professionals responded to this question, and so it appears that health professionals are largely unaware of risk factor surveys that have been conducted in their regions, potentially because these surveys are usually undertaken by groups that are independent of hospitals and because knowledge about these surveys does not help clinicians in caring for their patients (see supplement materials for more details).

Stroke prevention

Our survey data showed that only about one-third of the recommended primary prevention activities were in place in countries participating in the survey, and these activities were particularly poor in LICs. These findings are in line with the previous[16] and recent review of primary stroke prevention in the world,[17] suggesting that despite the numerous calls for action, stroke prevention remains a grossly neglected feature of the global development

agenda,[18] and measures for improving primary prevention strategies need to be urgently undertaken, with the emphasis on population-wide strategies.[17,19–21] Results of our survey on the low utilization of secondary stroke prevention strategies are in line with those from a recent survey of national scientific societies and stroke experts in Europe[22] and the results of the 2017 and 2019 WHO survey of 194 WHO Members States[23] (see Figure 5(a) and Supplementary materials for more details).

Acute stroke care

In our study, the classification of hospitals according to the WSO roadmap showed that only 35% of hospitals in this study had a minimum requirement to be a stroke center, with evidence-based interventions. This is even more concerning as most hospitals were university hospitals (77%) which may have more infrastructure than community or rural hospitals. In addition, it is likely that the surveyed hospitals may be the best stroke centers in the countries, especially in those countries with only one or two hospitals represented, such as Paraguay, Peru, Honduras, and Uruguay (Supplementary Table 3). These countries showed a high acute care services score in this study, but they have very few stroke centers in each country.[24]

On the other hand, a large upper-MIC like Brazil, where acute stroke care has improved substantially in the last years[24,25] still has a situation far from ideal. Stroke centers have a good structure and treatments available for acute care, but general hospitals in the country do not have minimal resources for stroke care. In the present study, of the 24 Brazilian hospitals evaluated, some of which are stroke centers, with full structure for acute care, and some of which are general hospitals, without structure for acute stroke care, the acute pillar score was only 30.9%, that better represents the situation in the country and not only the situation of stroke centers.

Some HICs are not well represented in the survey (few hospitals or incomplete information), and they had a low acute pillar score but per literature, they have a very well-organized acute stroke care network with good structure of hospitals such as Austria, Canada, France, Germany, Japan, Norway, Slovak, Sweden, United Kingdom, and United States.[24,26] Effective stroke care planning, on a national or regional level, and adequate resource allocation is fundamental to decrease the burden of stroke. Huge efforts have been made to increase the number of acute stroke hospitals around the world and to certify them, implementing reperfusion treatment and stroke units.[24,27] This is particularly significant as the time window for effective treatment is increasing. Our study demonstrated the disparities among the countries with the rates of implementation of recommended interventions increasing with the income level. This includes implementation of guidelines and protocols, availability of stroke units, acute stroke treatments, and basic acute care services.

Stroke rehabilitation

Our survey findings indicate major gaps in the quality and quantity of rehabilitation services for stroke across countries of all income strata including deficiencies in educational services, rehabilitation protocol and services in in-patient, outpatient and community settings, revealing enormous unutilized potential of holistic stroke rehabilitation to maximize the

health-related quality of life of the stroke survivor while prolonging life.[28,29] In LMICs, availability of rehabilitation services was inadequate in required quality and quantity compared to HICs.

The observed quantity and quality of rehabilitation services in LMICs is corroborated by findings from the World Health Organization NCD Survey (Figure 5(b)). Disparities across income groups were marked, with less than a third of LICs having either rehabilitation or acute care service available, compared to about half of lower-middle-income countries, and two thirds or more of upper-middle- and high-income countries. Rehabilitation for stroke patients was generally less available in each region compared with care for acute stroke; the South-East Asia Region was the only exception to this pattern. While RES-Q is focused on acute care, it also assessed some post-acute services, including recommendations for rehabilitation. The percentage of patients who were referred to see a rehabilitation specialist following treatment was clearly different among lower-MICs (65%), upper-MICs (88%), and HICs (88.2%).

Limitations and strengths

The relatively small number of hospitals or respondents participating in most countries makes our data less generalizable. It is likely that hospitals which participated represented the better hospitals, implying that the performance results may be overstated. However, attempts at obtaining similar country-level information from the Ministries of Health returned very low response rates, and acknowledgement by some of the Ministries that they did not have the requested information. Recognizing that there is no perfect way of processing the individual data for presentation, we have provided the complete anonymized raw individual responses for interested readers and policy makers (Appendix 3). The questions and scoring system are also available as Appendices 1 and 2.

The study has some strengths. First, the survey data were provided by local experts involved in stroke-related work including those who were practising in the respective countries and involved in day-to-day delivery of stroke services and are best suited to self-report the quantity and quality of stroke services in their practice domain and countries. Furthermore, this is the largest global survey of stroke services in terms of the number of countries covered. Our future surveys will aim to cover more countries.

Conclusions

Stroke surveillance, prevention, acute care, and rehabilitation services were inadequate in quality and quantity in LMICs. There is an urgent need to improve access to stroke units and services globally especially in LMICs. Countries with less stroke services can adapt strategies from those with better services. This could include establishment of a framework for regular monitoring of stroke burden and services, implementation of integrated prevention activities and essential acute stroke care services, and provision of interdisciplinary care for stroke rehabilitation. These activities require high-level participation from national healthcare policy makers and other stakeholders which can be coordinated through regional and global stroke control ecosytems.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

Data availability

The authors confirm that the data supporting the findings of this study are available as a supplementary file with raw data accessible.

References

1. Johnson CO, Nguyen M, Roth GA, et al. Global, regional, and national burden of stroke, 19902016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet Neurology 2019; 18: 439458.

2. Feigin VL, Norrving B and Mensah GA. Global Burden of Stroke. Circ Res 2017; 120: 439448.

3. Medeiros GC, Roy D, Kontos N, et al. Post-stroke depression: A 2020 updated review. Gen Hosp Psychiatry 2020; 66: 7080.

4. GBD Compare | IHME Viz Hub, http://vizhub.health-data.org/gbd-compare (accessed 11 November 2020).

5. Feigin VL, Lawes CMM, Bennett DA, et al. Worldwide stroke incidence and early case fatality reported in 56 population-based studies: a systematic review. Lancet Neurol 2009; 8: 355369.

6. Owolabi MO, Bower JH and Ogunniyi A. Mapping Africa's way into prominence in the field of neurology. Arch Neurol 2007; 64: 16961700.

7. Hankey GJ. The global and regional burden of stroke. Lancet Glob Health 2013; 1: e239–240. [PubMed: 25104481]

8. Sliwa K and Yacoub M. Catalysing the response to NCDI Poverty at a time of COVID-19. The Lancet 2020; 396: 941943.

9. GBD 2015 Neurological Disorders Collaborator Group. Global, regional, and national burden of neurological disorders during 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet Neurol 2017; 16: 877897.

10. Johnson W, Onuma O, Owolabi M, et al. Stroke: a global response is needed. Bull World Health Organ 2016; 94: 634–634A. [PubMed: 27708464]

11. Lindsay P, Furie KL, Davis SM, et al. World Stroke Organization global stroke services guidelines and action plan. Int J Stroke 2014; 9 Suppl A100: 413. [PubMed: 23981541]

12. Wechsler Lawrence R, Demaerschalk Bart M, Schwamm Lee H, et al. Telemedicine Quality and Outcomes in Stroke: A Scientific Statement for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2017; 48: e3e25. [PubMed: 27811332]

13. Saposnik G, Johnston SC, Raptis S, et al. Stroke journal: what is being published to advance the field? Stroke 2013; 44: 26442649.

14. Sposato LA and Saposnik G. Gross domestic product and health expenditure associated with incidence, 30-day fatality, and age at stroke onset: a systematic review. Stroke 2012; 43: 170177.

15. Asplund K, Hulter A sberg K, Appelros P, et al. The Riks-Stroke story: building a sustainable national register for quality assessment of stroke care. Int J Stroke 2011; 6: 99108.

16. World Health Organization, Public Health Agency of Canada (eds). Preventing chronic diseases: a vital investment. Geneva: [Ottawa]: World Health Organization; Public Health Agency of Canada, 2005.

17. Pandian JD, Gall SL, Kate MP, et al. Prevention of stroke: a global perspective. Lancet 2018; 392: 12691278.

18. Bonita R and Beaglehole R. Stroke prevention in poor countries: time for action. Stroke 2007; 38: 28712872.

19. Brainin M, Feigin VL, Norrving B, et al. Global prevention of stroke and dementia: the WSO Declaration. Lancet Neurol 2020; 19: 487488.

20. Brainin M and Sliwa K. WSO and WHF joint position statement on population-wide prevention strategies. The Lancet 2020; 396: 533534.

21. Feigin VL, Brainin M, Norrving B, et al. What Is the Best Mix of Population-Wide and High-Risk Targeted Strategies of Primary Stroke and Cardiovascular Disease Prevention? Journal of the American Heart Association 2020; 9 (3): e014494. [PubMed: 31983323]

22. Webb A, Heldner M, Aguiar de Sousa D, et al. Availability of secondary prevention services after stroke in Europe: An ESO/SAFE survey of national scientific societies and stroke experts. European Stroke Journal 2019; 4: 110118.

23. World Health Organization. Assessing national capacity for the prevention and control of NCDs. WHO, http://www.who.int/ncds/surveillance/ncd-capacity/en/ (2018, accessed 24 January 2020).

24. Ouriques Martins SC, Sacks C, Hacke W, et al. Priorities to reduce the burden of stroke in Latin American countries. Lancet Neurol 2019; 18: 674683.

25. Martins SCO, Pontes-Neto OM, Alves CV, et al. Past, present, and future of stroke in middle-income countries: the Brazilian experience. Int J Stroke 2013; 8 Suppl A100: 106111.

26. Aguiar de Sousa D, von Martial R, Abilleira S, et al. Access to and delivery of acute ischaemic stroke treatments: A survey of national scientific societies and stroke experts in 44 European countries. Eur Stroke J 2019; 4: 1328.

27. Chimatiro GL and Rhoda AJ. Scoping review of acute stroke care management and rehabilitation in low and middle-income countries. BMC Health Services Research 2019; 19: 789. [PubMed: 31684935]

28. Dieleman JL, Campbell M, Chapin A, et al. Future and potential spending on health 201540: development assistance for health, and government, prepaid private, and out-of-pocket health spending in 184 countries. The Lancet 2017; 389: 20052030.

29. Dieleman J, Campbell M, Chapin A, et al. Evolution and patterns of global health financing 19952014: development assistance for health, and government, prepaid private, and out-of-pocket health spending in 184 countries. The Lancet 2017; 389: 19812004.
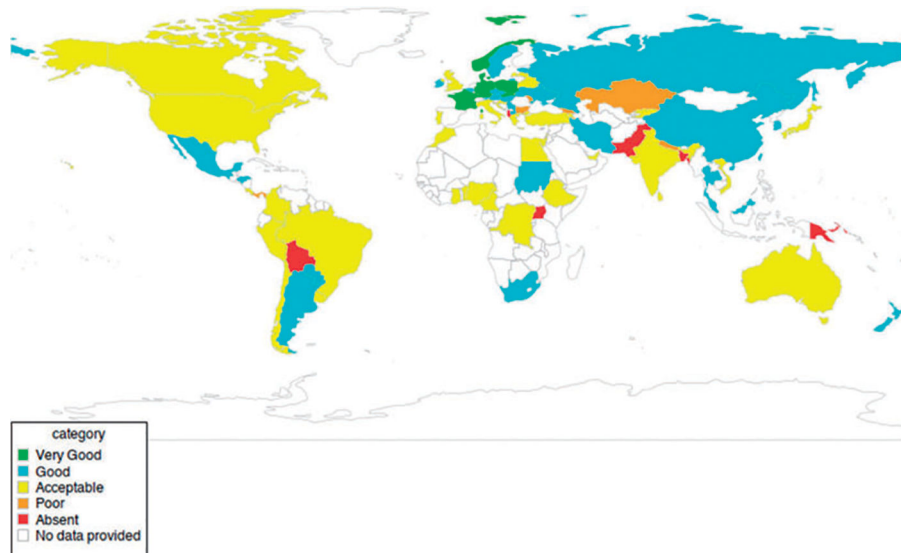
Figure 1.
Quintiles of performance by presence of surveillance strategies.

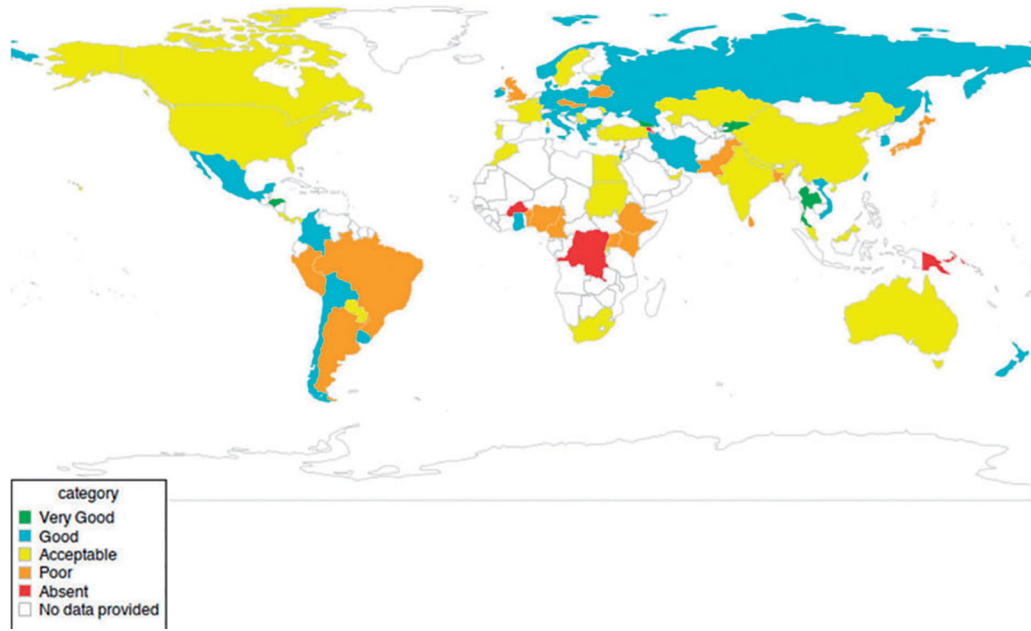**Figure 2.**
Quintiles of performance by presence of stroke prevention activities – secondary stroke prevention activities.
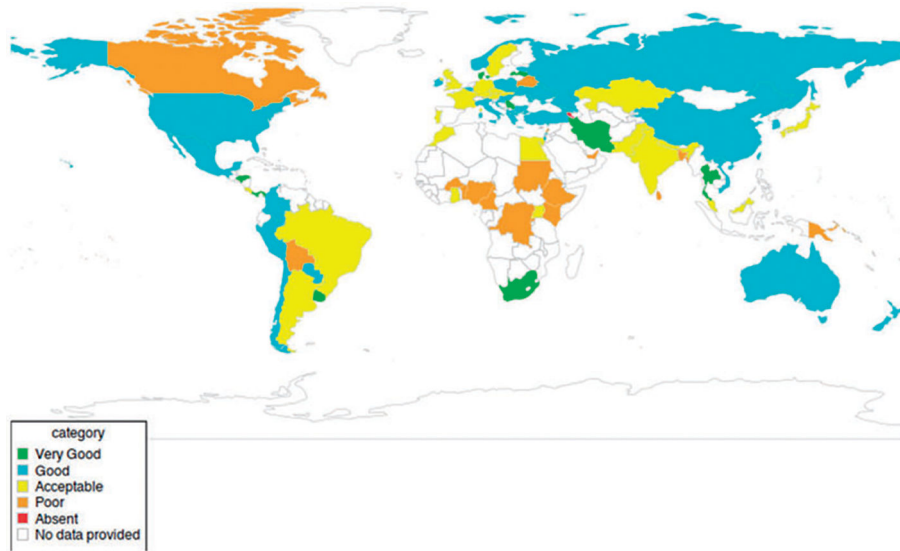
Figure 3.
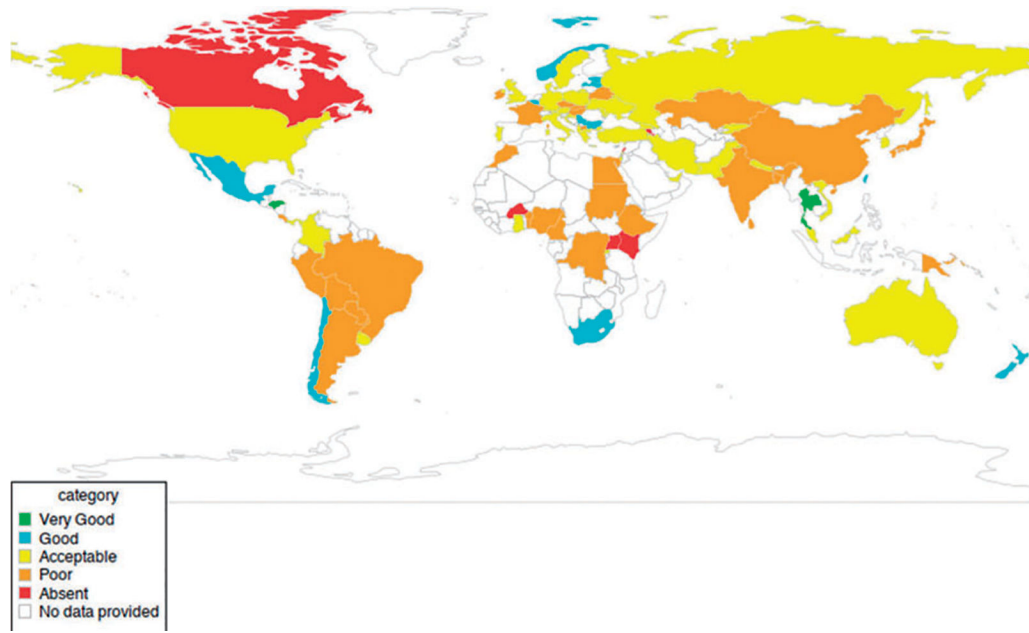Quintiles of performance by presence of acute stroke services.

Figure 4.
Quintiles of performance by presence of rehabilitation services.
The data obtained for Canada may not be representative of the entire country and should be interpreted with caution. See raw data for more details.
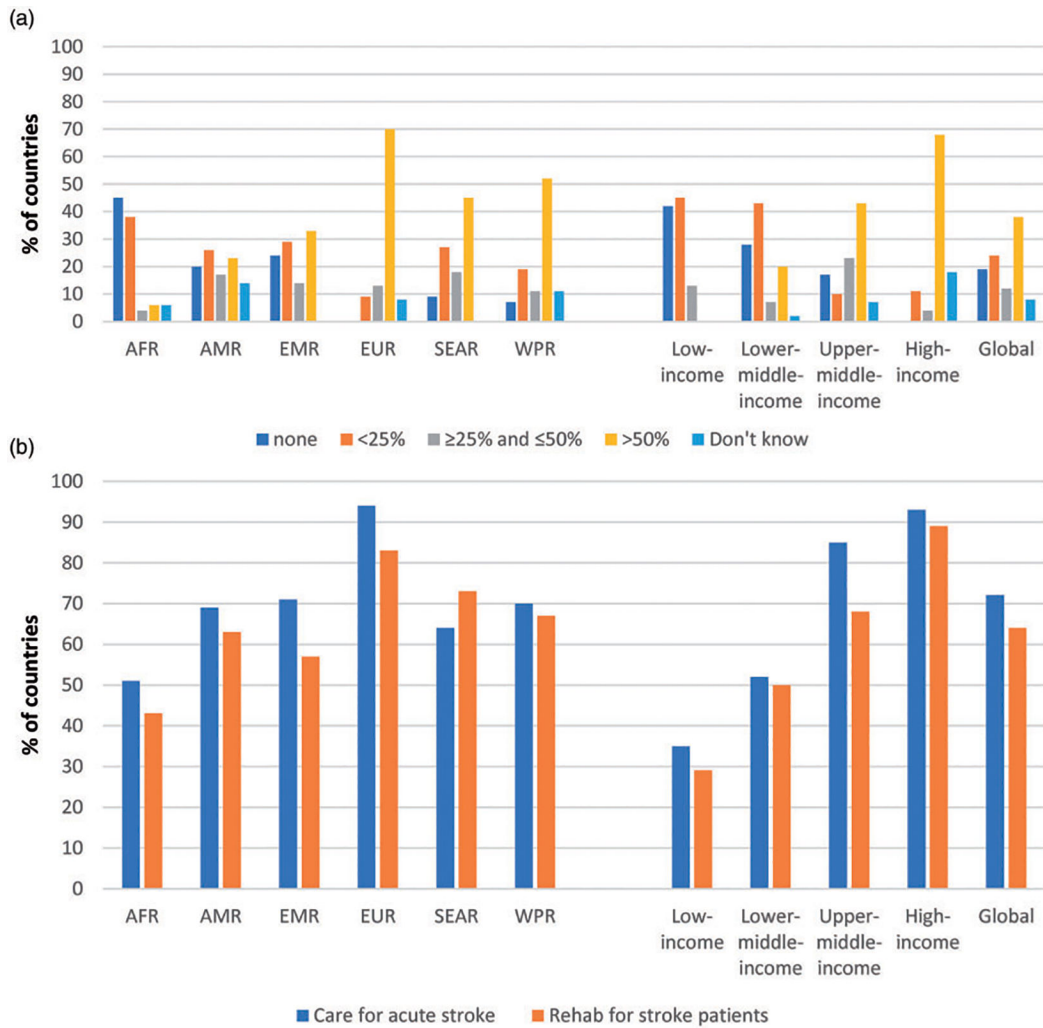
Figure 5.
(a) Percentage of primary health-care facilities offering cardiovascular risk stratification for the management of patients at high risk for heart attack and stroke, by WHO region and World Bank income group from the 2019 WHO NCD survey of 194 countries; (b) percentage of countries with available services for provision of care for acute stroke and rehabilitation, by WHO region and World Bank income group from the 2019 WHO NCD survey of 194 countries.

Table 1.

Stroke services available by regions (obtained from survey of health professionals)

Regions	No. of countries	Surveillance	Prevention	Acute	Rehabilitation
Global	84	43.6	40.2	48.9	35.1
GBD super-regions					
Central and Eastern Europe and Central Asia	19	38.0	48.2	58.6	38.2
High income	24	52.4	39.6	51.5	38.7
Latin America and Caribbean	10	39.9	32.3	41.0	27.5
North Africa and Middle East	7	39.6	43.7	55.5	37.0
South Asia	4	30.8	40.6	36.4	26.3
Southeast Asia, East Asia and Oceania	9	50.2	41.6	49.6	39.4
Sub-Saharan Africa	11	39.2	28.9	29.5	25.1
WHO regions					
African region	12	37.0	27.6	28.7	24.4
Eastern Mediterranean region	7	41.1	36.3	34.4	22.2
European region	34	43.9	44.4	55.1	39.1
Region of the Americas	15	43.4	34.7	46.5	31.9
South-East Asia region	5	34.7	40.8	39.7	28.3
Western Pacific region	11	52.3	42.7	54.5	41.0

GBD: Global Burden of Disease; WHO: World Health Organization.

Seventy-eight countries missing for surveillance (countries missing for GBD regions are one Central and Eastern Europe and Central Asia; one Latin America & Caribbean; one North Africa and Middle East; three sub-Saharan Africa; countries missing for WHO regions are three African Region; one Eastern Mediterranean Region; one European region; one Region of the Americas).

Good: 50% to <75% positive responses to services for the pillar.

Acceptable: 30% to <50% positive responses to services for the pillar.

Poor/low: <30% positive responses.

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Table 2.

Classification of the hospitals according to the WSO Road Map for acute stroke care by income level

World Bank Index	Advanced N (%)	Essential N (%)	Minimal N (%)	N
High income (34[a] countries)	27 (20.9)	23 (17.8)	75 (58.1)	129
Upper middle income (23 countries)	24 (22.0)	22 (20.2)	56 (51.4)	109
Lower middle income (21 countries)	5 (7.9)	9 (14.3)	41 (65.1)	63
Low income (6 countries)	0 (0)	1 (5.9)	14 (82.4)	17
Total, N (%)	56 (17.6)	55 (17.3)	186 (68.1)	318

N refers to number of reports by health professionals, with some hospitals reported more than once. See Table 1 for classification of Advanced, Essential, and Minimal.

Note that four hospitals from HI countries, seven from UMI countries, eight hospitals from LMI countries, and two from LI countries did not have services for stroke that reached minimal level of requirements, and so the numbers in each row do not sum to the number of hospitals in each region.

[a]Wales counted as a country.

Table 3.

The proportion of components available in the hospitals in relation to all recommended resources by the WSO Roadmap, categorized by income level

World Bank Index	Advanced	Essential	Minimal	N
High income (34[a] countries) (%)	92.3	77.3	17.3	125
Upper middle income (23 countries) (%)	84.6	73.2	22.6	102
Lower middle income (21 countries) (%)	78.6	72.6	23.1	55
Low income (six countries) (%)	NA	44.7	37.7	15
Total (%)	87.8	74.3	21.7	297

N refers to number of reports by health professionals, with some hospitals reported more than once.

NA means that there were no low-income countries categorized as advanced hospital.

See Table 1 for classification of Advanced, Essential, and Minimal.

[a]With Wales counted as a country.