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Original Article

Indonesian Stroke Management Neurointerventional Services Challenges

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Introduction: Stroke is a leading cause of death and disability in Indonesia. Currently, stroke management has become more aggressive, and neurointerventionists are required to optimize acute stroke management. **Objective:** to determine the distribution of neurointerventionists in Indonesia and identify the obstacles faced in neurointervention services. **Method:** This cross-sectional study used an online questionnaire distributed to neurointerventionists in Indonesia between October and November 2024. **Result:** A total of 105 neurointerventionists completed the questionnaires. The distribution of neurointerventionists remains concentrated in Java, especially in Jakarta. The highest ratio of neurointerventionists to stroke cases was observed in Jakarta, while the lowest was in Lampung. West Java identified the largest gap in the number of neurointerventionists compared to Jakarta. Notably, 20.9% of neurointerventionists had not performed any neurointerventional procedures, and 46.8% reported challenges related to the funding of neurointerventional procedures through government insurance. **Conclusion:** Despite the increasing number of neurointerventionists in Indonesia, their distribution remains concentrated in Java. The main barrier was the funding of neurointerventional procedures through government insurance.

Keywords: Challenges, Indonesia, Neurointervention, Stroke management

Highlights
- Stroke burden in Indonesia
- Challenges for Indonesian neurointerventionist

Introduction

Stroke continues to be Indonesia's leading cause of death and disability, causing significant financial burden.[1,2] Indonesia is an archipelago country comprising over 17,500 islands and a population of about 270 million. The prevalence of stroke in Indonesia is 0.0017% in rural areas and 0.022% in urban areas,; while the national average was 8.3‰.[1,3] Stroke management has shifted from passive to aggressive approach to reduce disability and mortality. Several years ago, the treatment for acute ischemic stroke was limited to intravenous administration of recombinant tissue plasminogen activator (rTPA IV). However, five randomized controlled trials (RCTs) found

significant clinical improvement in ischemic stroke patients who were treated with mechanical thrombectomy within 6-8 hours of symptom onset.[4–8] Further studies has prolonged mechanical thrombectomy's therapeutic window to 16 and even 24 hours from onset.[9,10]

Given the high incidence of stroke disabilities and mortality in Indonesia, the government developed a priority stroke serevice program through the Ministry of Health of the Republic of Indonesia (MoH RI). This priority service program includes increasing the procurement of CT scan and digital subtraction angiography (DSA) equipment in hospitals in Indonesian hospitals in order to improve acute stroke management services in the country. As the number of cath-lab devices grows, so does the number of doctors specialized as vascular interventional neurologists (neurointerventionists).

The Indonesian Neurology College established the neurointerventional fellowship program in Indonesia began in 2017. Prior to its inception, aspiring neurointerventionists completed their neurointerventional fellowships abroad (e.g., India, China, Vietnam, Switzerland, and South Korea). As of now, there are eight neurointerventional fellowship centers distributed across major cities in Indonesia: six in Java, one in Sulawesi, and one in Sumatera.

The first neurointerventionist in Indonesia, Dr. Fritz Sumantri, completed a fellowship in India in 2009. In 2010, there were only 8 neurointerventionists in Indonesia. This number of neurointerventionists increased slowly until 2015 and has started to rise rapidly since the opening of fellowship sites in Indonesia in 2017 continuing through 2024 (Figure 1).

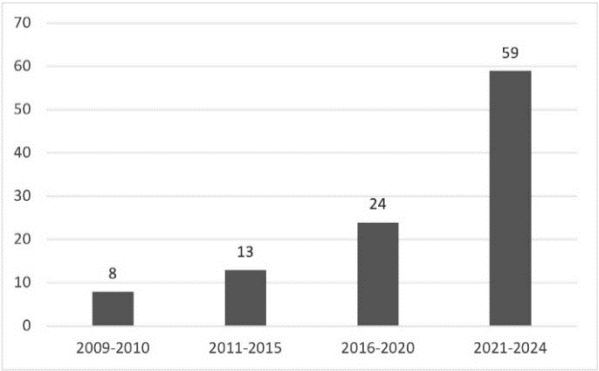

Figure 1. Increasing fellowship alumni in Indonesia.

Low public awareness of stroke prevention, a lack of acute stroke care neurologists and neurointerventionists, and inadequate national health insurance support remain challenges to reducing stroke morbidity and mortality in Indonesia. Despite advances in acute stroke therapy, access to neurointerventional services like mechanical thrombectomy is limited. As of 2020, Indonesia had only 54 neurointervention facilities, mostly on Java Island, leaving many regions underserved.[1]

This study addresses the following question: What is the current distribution and readiness of neurointervention services for stroke in Indonesia? We hypothesize that significant regional disparities exist in service provision, infrastructure, and procedural readiness due to systemic and logistical barriers. The findings of this study may help to guide strategies for improving neurointerventional services in Indonesia, as well as serve as a reference for other low- and middle-income countries facing similar challenges.

Objective

This study aimed to determine the distribution of neuro-interventionists in Indonesia, the ratio of neuro-interventionists to stroke cases, and the challenges encountered in establishing neurointerventional services in their respective hospitals, in light of the growing number of neurinterventionsts since 2017. Another purpose was to calculate the estimated gap between the existing number of neurointerventionists and the expected need for neurointerventionists in each province.

Method

This descriptive cross-sectional study was conducted by distributing online questionnaires to neurointerventionists across Indonesia. A total sampling method was used, with inclusion criteria being neurointerventionists who had completed their fellowship before July 2024 and consented to participate in the study. Descriptive analysis was performed using frequencies and percentages for categorical variables.

Questionnaire

The questionnaire, written in Bahasa Indonesia, contained the following questions: (1) province of work; (2) whether the hospital has catheterization laboratory (cath-lab) facilities; (3) location of neurointerventional fellowship training; (4) year of fellowship completion; (5) year of starting neurointerventional services at their current hospital; (6) challenges faced during the establishment of neurointerventional services; and (7) ongoing challenges currently faced.

Operational Definition

Neurointerventionist distribution was defined as the number of neurointerventionists in each province. The ratio of neurointerventionists to population in each province was calculated based on the provincial population data from 2024.[11] The ratio of neurointerventionists to stroke cases was calculated based on provincial stroke prevalence data from 2023.[3] The workforce gap was calculated as the difference between the required and current number of

neurointerventionists in each province. Currently, there is no ideal ratio of neurointerventionists to stroke patients. As a result, the appropriate number of neuro-interventionists required was determined using Jakarta's neurointerventionists-to-stroke cases ratio. This determination was based on the rationale that Jakarta's stroke services are relatively well-resourced in terms of human resources and facilities compared to other provinces.

Result

The questionnaire was completed by 105 Indonesian neurointerventionists. Prior to 2017, the most neurointerventionists had completed their fellowships a in India, followed by South Korea, Switzerland, Vietnam, and China Table 1.

Table 1. The characteristic of research sample

Variants	N
Place of fellowship (n = 105)	
Abroad	32 (30.5%)
Indonesia	73 (69.5%)
Fellowship program in abroad (n =32)	
India	24
South Korea	3
Switzerland	2
Vietnam	2
China	1
Fellowship program in Indonesia (n = 73)	
Dr. Moewardi Hospital, Solo	4
Dr. Soetomo Hospital, Surabaya	6
Dr. Wahidin Soedirohusodo, Makassar	9
Fatmawati Hospital, Jakarta	15
PELNI Hospital, Jakarta	34
National Brain Centre Hospital, Jakarta	5
Years of Neurointervention practice (until 2024)	
0	11
1	9
2	7
3	9
4	5
5	7
6	2
7	3
8	2
9	1
10	5
11	1
13	2
14	3
15	1

The distribution of neurointerventionists and neurointervention facilities across provinces is shown in Table 2. Of the 105 neurointerventionist, 59 were practicing in Java, with the majority concentrated in Jakarta. Up to October 2024, these neurointerventionists were practicing in 165 hospitals equipped with neurointervention facilities, and 61% of them were in Java.

Table 2. Distribution of neurointerventionists and Neurointervention facilities in Indonesia, and gap of number of neurointerventionist

Province	N (%)	Neurointervention facilities	Neurointerventionist: Population (thousands) Ratio*	Gap***
Java	**59 (56.2%)**	**101**		
Jakarta	19	28	1:464.5	Reference
Banten	4	11	1:3,107.7	17
West Java	11	24	1:4,576.8	76
Central Java	10	16	1:3,789.2	57
Yogyakarta	4	7	1:939.75	3
East Java	11	15	1:3,801.3	64

Table 2 continued. Distribution of neurointerventionists and Neurointervention facilities in Indonesia, and gap of number of neurointerventionist

Province	N	Neurointervention facilities	Neurointerventionist: Population (thousands) Ratio*	Gap***
Bali - Nusa Tenggara	**7 (6.7%)**	**9**		
Bali	4	11	1:1,108.3	4
West Nusa Tenggara	2	24	1:2,823	7
East Nusa Tenggara	1	16	1:5,656	8
Sumatra	**21 (20%)**	**31**		
Aceh	2	3	1:2,777	7
North Sumatra	5	9	1:3,117.6	21
West Sumatra	3	3	1:1,945.4	7
Jambi	1	2	1:3,724.3	5
Riau	4	8	1:1,682	7
South Sumatra	5	5	1:1,472.8	10
Lampung	1	1	1:4,709.8	15
Bengkulu	0	NA	NA	4
Bangka - Belitung	**1 (0.9%)**	**1**	1:5,695.5	2
Kalimantan	**6 (5.7%)**	**7**		
West Kalimantan	1	1	1:5,695.5	9
South Kalimantan	2	2	1:2,136.7	5
Central Kalimantan	1	2	1:2,809.7	4
East Kalimantan	2	2	1:2,022.5	5
North Kalimantan	0	NA	NA	1
Sulawesi	**8 (7.6%)**	**11**		
North Sulawesi	1	1	1:2,701.8	4
Central Sulawesi	3	3	1:1,040.6	2
Southeast Sulawesi	1	2	1:2,793.1	3
South Sulawesi	3	5	1:3,154.5	13
Gorontalo	0	NA	NA	2
Maluku	**1 (0.9%)**	**2**	1:1,945.6	2
North Maluku	0	NA	NA	2
Papua	**2 (1.9%)**	**3**	1:4,542.6	0
West Papua	0	NA	NA	1
Southwest Papua	0	NA	NA	1
South Papua	0	NA	NA	1
Central Papua	0	NA	NA	2
Papua's mountain	0	NA	NA	2
Total	**105**	**165**		**373**

The ratio of neurointerventionists to population was lowest in West Kalimantan (1:5,965,500 people) and highest in Jakarta (1:464,500). Some provinces had only a single practicing neurointerventionist, including East Nusa Tenggara, Jambi, Lampung, West Kalimantan, Central Kalimantan, North Sulawesi, Southeast Sulawesi, and Maluku. The ratio of current neurointerventionists to stroke cases was highest in Jakarta (1:1,315) and lowest in Lampung (1:21,021). Figure 2 shows the ratio of neurointerventionists to stroke cases in each province. Some provinces had no practicing neurointerventionists, including North Kalimantan, Gorontalo, North Maluku, the Riau Islands, and West Papua. Using Jakarta as a reference point for stroke services in Indonesia, gaps would exist with other provinces. The largest gap was observed in West Java, followed by East Java. In Papua, the largest province in Indonesia, seven neurointerventionists would be required to match Jakarta's ratio. Up to 2024, Papua had two neurointerventionists; thus, five were needed to fill the gap. Overall, the total estimated gap among neurointerventions across Indonesia was 373.

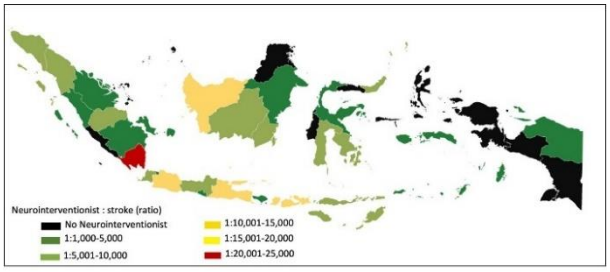

Figure 2. The ratio number of neurointerventionist in each province.

Table 3 shows the barriers faced by neurointerventionists in delivering stroke management services. As of 2024, 20.9% of neurointerventionists had not yet performed neurointerventional services. Among the 83 neurointerventionists that underwent neurointervention procedures, 49.4% report a delay of 1 to 3 years before starting their first procedure. Two people experienced delays exceeding three years, with one reporting a delay of up to ten years post-fellowship. However, 48.2% were able to perform neurointervention procedures within one year of completing their fellowship.

Table 3. Barriers of doing Neurointervention service

Variable	N (%)
Time for the first neurointerventional service to start (n = 105)	
Not yet doing the service	22 (20.9)
Year 2009-2010	4 (3.8)
Year 2011-2015	13 (12.4)
Year 2016-2020	22 (20.9)
Year 2021-2024	44 (41.9)
Time for fellowship completion to the first Neurointervention service (year) (n = 105)	
< 1	40 (48.2)
1-3	41 (49.4)
> 3	2 (2.4)
Types of obstacles when pioneering neurointerventional services (n=88)	
Catheterization laboratory was not available	3 (3.4)
Angiography suite was available but not Ready	15 (17)
Not trained nurses	3 (3.4)
Procedures were not funded by government insurance programs	50 (56.9)
Others	17 (19.3)
Still facing barriers to neurointerventional service (n =83)	
Procedures not being reimbursed	22 (34.9)
Reimbursement values being lower than actual costs	19 (30.2)
Differing claims policies across hospitals	6 (9.5)
Others	16 (25.4)

Among 83 neurointerventionists who had previously performed neurointerventional procedures, 63 (75.9%) reported ongoing challenges. Government insurance coverage was one of the most common persistent problems, which include: (a) non-reimbursed treatments (34.9%), (b) reimbursement rates lower than actual costs (30.2%), and (c) variability in claims policies across hospitals (9.5%). Other challenges (25.4%) included limited availability of medical supplies, lack of skilled personnel such as nurses and radiographers, and time-sharing issues in angiography suites shared with other specialties like cardiology, neurosurgery, and radiology.

We have added a pie chart (Figure 3) to enhance clarityand visualize the challenges faced when pioneering neurointerventional services. The most reported challenge was the lack of funding by government insurance programs (56.9%), followed by an unprepared catheterization laboratory (17%), and other issues (19.3%), such as inter-specialty conflicts and scheduling limitations. Minor issues included the absence of cath-lab facilities or trained staff.

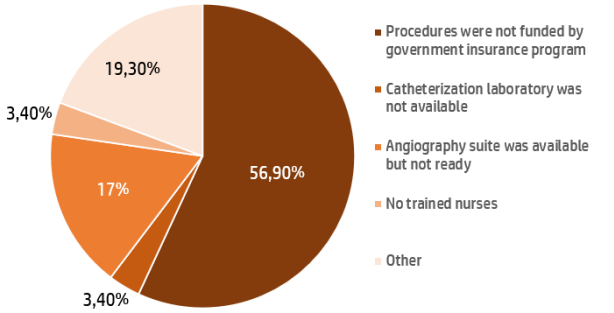

Figure 3. Distribution of obstacles faced when pioneering neurointerventional services in Indonesia (n = 88).

Responses in the 'Others' category included resistance from specialists in other disciplines, and scheduling conflicts with other cath-lab users such as cardiologists, neurosurgeons, and radiologists.

Discussion

Distribution of Neurointerventionists and Facilities

Indonesia stroke cases are rising significantly. In response, the government was committed to reducing stroke incidence and improving outcomes by expanding access to cath-lab and neurointervention facilities across all provinces. As the number of neurointervention facilities in Indonesia grows, so does the need for more intervention specialists, particularly neurointerventionists. Since 2017, the number of neurointerventional fellowship sites has increased significantly, as has the number of neurointerventionist. Specialists with competence in endovascular intervention are particularly needed for acute stroke management that requires thrombectomy. Thrombectomy offers a wider therapeutic window and better clinical outcomes compared to intravenous or intra-arterial thrombolysis.[10] Neurologist, neurosurgeons, and radiologists in Indonesia were among the doctors who were competent in endovascular interention for stroke. It was the same as in other Asian countries, such as Japan, South Korea, Thailand, and Vietnam.[12]

As of October 2024, 105 neurointerventionists were providing neurointerventional services throughout 165 hospitals in Indonesia. The number of neurointervention facilities has grown rapidly, increasing from 54 in 2022 to 105 now.[1] However, the distribution of neurointerventionists across Indonesia is uneven. Despite certain provinces having similar stroke prevalence as Jakarta, the number of neurointerventionists was much different. To achieve the same ratio of neurointervention to stroke cases as Jakarta, 373 gaps needed to be addressed throughout all Indonesian provinces. If this gap isn't filled, stroke deaths and disabilities may rise. The lack of a number of neurointerventionists was also problem in other Asia country such as Nepal. There were

only ten neurointerventionists in Nepal who performed neurointerventional procedure.[13] According to the World Stroke Organization survey in 2018, the ratio of neurologists and neurosurgeons per 1000 annual incidence stroke patients varied widely around world. The ratio of neurologist and neurosurgeon per 1000 annual incident stroke in Asia countries was < 5.[12]

Obstacles Faced

Despite the increasing number of neurointerventionists, significant challenges persist in both initiating and sustaining neurointerventional services. During the initial phase, hospitals frequently encountered administrative delays, insufficient institutional support, and limited access to cath-labs or essential consumables. Many neurointerventionists reported that they had not performed any procedures yet, with one of the most significant barriers being the insufficiency of the government insurance funding system.

Insurance funding policies from the government varied by region, resulting in uneven standards for stroke care. Some neurointerventionists said that the procedures accepted by government insurance varied across hospitals. In some cases, the reimbursement value was lower than the actual unit cost of the procedure, rendering treatments such as thrombectomy could not be performed. Another obstacle was the unavailability of medical supplies and specialized endovascular interventional equipment.

Even after services were established, ongoing challenges persisted, including inconsistent government insurance coverage, inadequate reimbursement rates, limited trained support staff (e.g., nurses, radiographers), and scheduling conflicts in shared angiography suites. This situation hinders the delivery of optimal stroke management, even though the hospital had human resources and lab facilities. This study shows that an increase in the number of neurointerventionists is meaningless without an equitable distribution of neurointerventionists in all provinces, a good government insurance financing system, medical supply distribution, especially outside Java, and procedure rate improvements.

This study has several limitations. First, it relied on self-reported data, which could create recall bias. Second, while we achieved a high response rate, the findings may not capture the insights from neurointerventionists who declined participation. Lastly, the study did not evaluate patient outcomes, which could offer additional details about the clinical impact of the reported barriers. Further research is required to find out how many stroke cases are untreatable with endovascular intervention therapy because of administrative factors, government insurance funding, and the availability of medical supplies. A mixed-method design can be used to explore patient-level outcomes and stakeholder interviews across hospitals. Regional health economic analysis is also warranted to determine the cost-effectiveness of neurointervention in Indonesia's universal health system.

Future Directions

As an archipelago, Indonesia needs to establish a network system of comprehensive stroke centers with neurointervention facilities. The Indonesia Neurology Association together with the Health Ministry, could help smaller hospitals with remote consultations and triage via telemedicine and transportation. Therefore, acute stroke cases requiring thrombectomy should be referred immediately.

Despite increasing the centers of the neurointervention training program in Indonesia, the current number of neurointerventionist remains insufficient to fill the gaps between urban and rural areas. Collaboration with international organizations or overseas centers could help accelerate the number of neurointerventionist. However, because neurointerventions are costly treatments, the increased number of neurointerventionist and facilities must be accompanied with improvements to Indonesia's health insurance system. The government and Indonesia Neurology association must sit together to equalize health insurance funding for all hospitals, especially for acute stroke cases requiring neurointerventional procedure (e.g. intra-arterial thrombolysis, thrombectomy).

Conclusion

Acute stroke management has evolved rapidly and aggressively, and it is now clear that neurointerventionists are required. Indonesian neurointerventionists have grown significantly in the past five years due to a government program to improve hospital cath-lab devices. However, most neurointerventionists are in Java, leading to significant disparities in access to care across provinces. Numerous challenges remain in achieving optimal acute stroke management. The biggest challenge is financing endovascular intervention procedures through government insurance, which needs to be addressed.

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Conflict of Interest

All authors have no conflict of interest to disclose.

Ethic consideration

This research doesn't have ethical clearance because we only use questionnaire and didn't do any experiment to research subject.

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Author contribution

Fritz Sumantri Usman, Fitri Octaviana: Planning and conducting research, and also writing the manuscript. **Merlin P Kastilong and Leny Kurnia:** Supporting research and writing manuscript. **Theodorus K Hendartono, Andika S Atmadja, and Yan L Tambunan:** Computing the data. **Achmad Firdaus Sani, Syahrul, and Dodik Tugasworo Pramukarso:** provided feedback and helped to shape the study.

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