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A Study on the Healthcare Workforce and Care for Acute Stroke: Results From the Survey of Hospitals Included in the National Acute Stroke Quality Assessment Program

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Address for Correspondence:

Seung Hun Sheen, MD, PhD

Department of Neurosurgery, CHA Bundang Medical Center, CHA University College of Medicine, 59 Yatap-ro, Bundang-gu, Seongnam 13496, Republic of Korea.
Email: nssheen@gmail.com

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ORCID iDs

Jong Young Lee

<https://orcid.org/0000-0002-0883-841X>

Jun Kyeong Ko

<https://orcid.org/0000-0002-5652-7659>

Hak Cheol Ko

<https://orcid.org/0000-0001-8745-3309>

Hae-Won Koo

<https://orcid.org/0000-0001-7014-3005>

Hyon-Jo Kwon

<https://orcid.org/0000-0003-1077-2461>

Dae-Won Kim

<https://orcid.org/0000-0003-2151-2841>

Kangmin Kim

<https://orcid.org/0000-0002-7409-4412>

Myeong Jin Kim

<https://orcid.org/0000-0001-5855-5533>

Hoon Kim

<https://orcid.org/0000-0003-1841-0991>

Jong Young Lee ¹, Jun Kyeong Ko ², Hak Cheol Ko ³, Hae-Won Koo ⁴, Hyon-Jo Kwon ⁵, Dae-Won Kim ⁶, Kangmin Kim ⁷, Myeong Jin Kim ⁸, Hoon Kim ⁹, Keun Young Park ¹⁰, Kuhyun Yang ¹¹, Jae Sang Oh ¹², Won Ki Yoon ¹³, Dong Hoon Lee ¹⁴, Ho Jun Yi ¹⁵, Heui Seung Lee ¹⁶, Jong-Kook Rhim ¹⁷, Dong-Kyu Jang ¹⁸, Youngjin Jung ¹⁹, Sang Woo Ha ²⁰, and Seung Hun Sheen ²¹

¹Department of Neurosurgery, Hallym University Gangdong Sacred Heart Hospital, Seoul, Korea

²Department of Neurosurgery, Biomedical Research Institute, Pusan National University Hospital, School of Medicine, Pusan National University, Busan, Korea

³Department of Neurosurgery, Kyung Hee University Hospital at Gangdong, Kyung Hee University College of Medicine, Seoul, Korea

⁴Department of Neurosurgery, Inje University Ilsan Paik Hospital, Inje University College of Medicine, Goyang, Korea

⁵Department of Neurosurgery, Chungnam National University Hospital, Chungnam National University School of Medicine, Daejeon, Korea

⁶Department of Neurosurgery, Institute of Wonkwang Medical Science, Wonkwang University School of Medicine, Iksan, Korea

⁷Department of Neurosurgery, Seoul National University Hospital, Seoul National University College of Medicine, Seoul, Korea

⁸Department of Neurosurgery, Gil Medical Center, Gachon University College of Medicine, Incheon, Korea

⁹Department of Neurosurgery, Bucheon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

¹⁰Department of Neurosurgery, Severance Hospital, Yonsei University College of Medicine, Seoul, Korea

¹¹Department of Neurosurgery, Gangneung Asan Hospital, University of Ulsan College of Medicine, Gangneung, Korea

¹²Department of Neurosurgery, Uijeongbu St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

¹³Department of Neurosurgery, Korea University Guro Hospital, Seoul, Korea

¹⁴Department of Neurosurgery, St. Vincent's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

¹⁵Department of Neurosurgery, Soonchunhyang University Bucheon Hospital, Bucheon, Korea

¹⁶Department of Neurosurgery, Hallym University Sacred Heart Hospital, Anyang, Korea

¹⁷Department of Neurosurgery, Jeju National University Hospital, Jeju National University College of Medicine, Jeju, Korea

¹⁸Department of Neurosurgery, Incheon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Incheon, Korea

¹⁹Department of Neurosurgery, Yeungnam University Medical Center and Yeungnam University Medical School, Daegu, Korea

²⁰Department of Neurosurgery, Chosun University Hospital, Gwangju, Korea

²¹Department of Neurosurgery, CHA Bundang Medical Center, CHA University College of Medicine, Seongnam, Korea

Keun Young Park 
<https://orcid.org/0000-0002-3254-4577>
 Kuhyun Yang 
<https://orcid.org/0000-0003-0019-6122>
 Jae Sang Oh 
<https://orcid.org/0000-0003-4570-6763>
 Won Ki Yoon 
<https://orcid.org/0000-0003-3715-0718>
 Dong Hoon Lee 
<https://orcid.org/0000-0002-3796-8707>
 Ho Jun Yi 
<https://orcid.org/0000-0003-3061-0689>
 Heui Seung Lee 
<https://orcid.org/0000-0002-4075-710X>
 Jong-Kook Rhim 
<https://orcid.org/0000-0003-2538-8374>
 Dong-Kyu Jang 
<https://orcid.org/0000-0002-6736-1818>
 Youngjin Jung 
<https://orcid.org/0000-0002-9659-2607>
 Sang Woo Ha 
<https://orcid.org/0000-0002-0409-2737>
 Seung Hun Sheen 
<https://orcid.org/0000-0002-0454-8810>

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Author Contributions

Conceptualization: Lee JY, Sheen SH. Data curation: Lee JY. Formal analysis: Lee JY, Sheen SH. Funding acquisition: Lee JY. Investigation: Ko JK, Ko HC, Koo HW, Kwon HJ, Kim DW, Kim K, Kim MJ, Kim H, Park KY, Yang K, Oh JS, Yoon WK, Lee DH, Yi HJ, Lee HS, Lee JY, Rhim JK, Jang DK, Jung Y, Ha SW. Methodology: Lee JY, Sheen SH. Software: Lee JY, Sheen SH. Validation: Lee JY, Sheen SH, Kwon HJ, Jang DK. Visualization: Lee JY. Writing - original draft: Lee JY. Writing - review & editing: Lee JY, Sheen SH, Kwon HJ.

ABSTRACT

Background: With growing elderly populations, management of patients with acute stroke is increasingly important. In South Korea, the Acute Stroke Quality Assessment Program (ASQAP) has contributed to improving the quality of stroke care and practice behavior in healthcare institutions. While the mortality of hemorrhagic stroke remains high, there are only a few assessment indices associated with hemorrhagic stroke. Considering the need to develop assessment indices to improve the actual quality of care in the field of acute stroke treatment, this study aims to investigate the current status of human resources and practices related to the treatment of patients with acute stroke through a nationwide survey.

Methods: For the healthcare institutions included in the Ninth ASQAP of the Health Insurance Review and Assessment Service (HIRA), data from January 2022 to December 2022 were collected through a survey on the current status and practice of healthcare providers related to the treatment of patients with acute stroke. The questionnaire consisted of 19 items, including six items on healthcare providers involved in stroke care and 10 items on the care of patients with acute stroke.

Results: In the treatment of patients with hemorrhagic stroke among patients with acute stroke, neurosurgeons were the most common providers. The contribution of neurosurgeons in the treatment of ischemic stroke has also been found to be equivalent to that of neurologists. However, a number of institutions were found to be devoid of healthcare providers who perform definitive treatments, such as intra-arterial thrombectomy for patients with ischemic stroke or cerebral aneurysm clipping for subarachnoid hemorrhage. The intensity of the workload of healthcare providers involved in the care of patients with acute stroke, especially those involved in definitive treatment, was also found to be quite high.

Conclusion: Currently, there are almost no assessment indices specific to hemorrhagic stroke in the ASQAP for acute stroke. Furthermore, it does not reflect the reality of the healthcare providers and practices that provide definitive treatment for acute stroke. The findings of this study suggest the need for the development of appropriate assessment indices that reflect the realities of acute stroke care.

Keywords: Acute Stroke; Hemorrhagic Stroke; Ischemic Stroke; Healthcare Workforce; Neurosurgery; Neurology

INTRODUCTION

As one of the most common causes of death worldwide, stroke is also a major societal burden due to its sequelae.¹ According to the National Health Insurance data, from 2011 to 2015, the crude incidence of stroke remained at around 200 per 100,000 people, then spiked to 218.4 in 2019 before declining slightly to 208.0 in 2020. However, age-standardized incidence continued to decline by 25% from 2011 to 2020. Despite the decrease in age-standardized incidence, the total number of stroke events in South Korea continues to increase due to the rapid growth of the aging population. Moreover, while the incidence decreased, mortality increased in 2020.² To ensure the timely and appropriate treatment and management of such serious diseases, the Health Insurance Review and Assessment Service (HIRA), in accordance with the National Health Insurance Act, has been conducting the Acute Stroke Quality Assessment Program (ASQAP) at 1- to 2-year intervals since the first assessment in 2006. Acute stroke is defined as cases where the primary diagnosis falls under International Classification of Diseases (ICD) codes I60–63, and the patient is

admitted through the emergency room within seven days of symptom onset. The evaluation is based on nine assessment indices, which include: the presence of specialized personnel, the rate of brain imaging, the rate of intravenous thrombolytic therapy within 60 minutes, the rate of consideration for intravenous thrombolytic therapy, the rate of early rehabilitation assessment within five days, the rate of dysphagia screening, the prescription rate of antithrombotic agents at discharge, the prescription rate of anticoagulants at discharge, and the average length of stay per admission as a long-term indicator. In addition, 15 monitoring indices are included, such as: the presence of a stroke unit, the rate of ambulance use, the median time from symptom onset to emergency room arrival, the implementation rate of stroke scale, the implementation rate of functional outcome scales, the rate of intravenous thrombolytic therapy, the rate of antithrombotic therapy, the rate of early rehabilitation treatment, the median number of days until the start of early rehabilitation, the rate of lipid profile testing, the rate of smoking cessation education, in-hospital mortality, 30-day post-admission mortality, the cost per case as a high-cost indicator, and the rate of pneumonia during hospitalization. A total of 24 indicators are used in the assessment.

Nevertheless, the prevalence of disability from stroke remains high, particularly for hemorrhagic stroke, which has higher mortality and disability rates compared to those of ischemic stroke. There is a need to improve stroke assessment indices focused on this population.³⁻⁶ The lack of hemorrhagic stroke-specific measures in the current stroke assessment indices seems to limit improvements in the actual quality of care for acute stroke despite many advances and collaborative efforts of healthcare institutions since the initial implementation of the assessment.⁷ This survey and study aim to investigate the current staffing and care for ischemic stroke and hemorrhagic stroke in hospitals included in the current ASQAP. It seeks to serve as a basis for developing indices for acute ischemic stroke and the relatively underdeveloped domain of hemorrhagic stroke, as well as for improving hospitals' response capability for acute stroke, including hemorrhagic stroke.

METHODS

This survey was conducted with healthcare institutions that were included in the Ninth ASQAP of the HIRA. The country was divided into 21 regions, and a regional director was appointed to be in charge of selecting survey participants for each hospital and encouraging them to respond to the survey. The questionnaire was sent directly to specialists in neurosurgery, neurology, or radiology at each hospital via email and filled out directly in the form of a web survey. Among the 251 healthcare institutions that were included in the Ninth ASQAP, 19 institutions that were disqualified were excluded, leaving a total of 232 institutions for the final survey.

In September 2022, a study committee was formed under the leadership of the chairman of the Acute Stroke Treatment Research Organization (ASTRO) under the Korean Neuroendovascular Society (KoNES) to survey the current status of healthcare providers involved in acute stroke treatment in South Korea. A draft questionnaire was developed by the study committee from January through March 2023 to investigate the current state of staffing, treatment, facilities, and practices in healthcare institutions treating patients with acute stroke. The developed draft was finalized through internal discussion and revision of the web-based questionnaire by the study committee, simulation for the institutions by the regional directors, and discussion and revision of the questionnaire, surveyed hospitals, and

Table 1. Questionnaire overview

Criteria	Core question
Hospital status	1. Number of beds 2. Hospital type (tertiary hospitals, general hospitals, or hospitals) 3. Location
The healthcare workforce involved in stroke care	1. Number of specialists from each department involved in the care of acute stroke (I60–I63) patients 2. Number of specialists from each department capable of performing emergency surgeries to remove the hematoma for patients with acute cerebral hemorrhage (I61–I62) 3. Number of specialists from each department capable of performing emergency surgeries such as cerebral aneurysm clipping for patients with subarachnoid hemorrhage (I60) 4. Number of specialists from each department capable of performing emergency cerebrovascular interventions such as coil embolization and cerebral arteriovenous malformation embolization for patients with acute cerebral hemorrhage (I61–I62) 5. Number of specialists from each department capable of performing emergency surgeries such as craniotomy or arterial bypass for patients with acute cerebral infarction (I63) 6. Number of specialists from each department capable of performing emergency cerebrovascular interventions such as IA thrombectomy for patients with acute cerebral infarction (I63)
Current status of acute stroke care	1. Decision-makers for the diagnosis and treatments of acute stroke (I60–I62) patients in ER 2. Decision-makers for the diagnosis and treatments of patients with acute cerebral infarction (I63) in ER 3. Decision-makers for IA thrombectomy in patients with acute cerebral infarction (I63) 4. Patient management after emergency surgeries for acute stroke (I60–I62) 5. Patient management after emergency cerebrovascular interventions for acute stroke (I60–I62) 6. Patient management after emergency surgeries such as craniotomy or arterial bypass for acute cerebral infarction (I63) 7. Patient management after emergency cerebrovascular interventions for acute cerebral infarction (I63)
Current status of care related to emergency surgeries or interventions	1. Monthly frequency of specialists staying on-call for emergency surgeries or cerebrovascular interventions for acute stroke patients 2. Monthly frequency (previous year) of specialists attending the hospital for emergency surgeries or cerebrovascular interventions for acute stroke patients outside of regular working hours (6:00 p.m. that day to 8:00 a.m. the next day) 3. Outpatient treatments after emergency surgeries or interventions for acute stroke patients scheduled outside of regular working hours (6:00 p.m. that day to 8:00 a.m. the next day)

IA = intra-arterial, ER = emergency room.

the survey process by the board of directors at KoNES. KoNES conducted the survey. The questionnaire consisted of 19 items, including six items on the healthcare providers involved in stroke treatment, seven items on the treatment of patients with acute stroke, and three items on the emergency surgery or procedure for patients with acute stroke (**Table 1**). The answers to each item were filled out by examining data from January 2022 through December 2022 at each hospital.

The first round of questionnaires was sent out in May 2023 after the finalization of the web-based survey system, and non-responding hospitals were encouraged to respond with reminder emails and phone calls from regional directors. Hospitals with insufficient responses were instructed to supplement their responses via follow-up emails, and the web survey was closed in November 2023.

The survey results were analyzed for hospitals with a response rate of at least 80% for each item.

RESULTS

Among the 232 organizations surveyed, 149 (63.9%) responded to the survey. There were 30 hospitals in Seoul, 23 in Gyeonggi-do, 11 in Busan, 10 in Incheon, nine in Daejeon, seven in Gwangju, six in Daegu, two in Ulsan, and 51 in other regions, indicating no differences in the distribution of hospitals by region (**Table 2**). Hospital types showed that general hospitals were the most common at 106 (71.1%), followed by advanced general hospitals at 43 (28.9%). Regarding the number of beds, hospitals with 601–1,000 beds were the most common at 55 (36.9%), followed by 301–600 beds at 45 (30.2%), 100–300 beds at 35 (23.6%), and 1,001 or

Table 2. Regional distribution of healthcare institution levels

Variables	Level 1	Level 2	Level 3	Level 4	Level 5	P value ^a
Seoul metropolitan area	46 (86.7)	3 (5.7)	1 (1.9)	3 (5.7)	0	0.982
Regional metropolitan areas	35 (77.8)	5 (11.1)	2 (4.4)	2 (4.4)	1 (2.3)	
Other regions	32 (62.7)	11 (21.6)	6 (11.8)	2 (3.9)	0	

Values are presented as number (%).

^aP values were calculated by analysis of variance.

more beds at 14 (9.3%). The ASQAP classification revealed 113 (75.8%) hospitals as level 1, 19 (12.8%) as level 2, 9 (6.0%) as level 3, 7 (4.7%) as level 4, and 1 (0.7%) as level 5.

The healthcare workforce involved in stroke care

As for the number of specialists in each department involved in the care of patients with acute stroke with ICD codes I60 through I63, there were two hospitals with no neurosurgeons on staff, 25 hospitals with one neurosurgeon, 40 hospitals with two neurosurgeons, 45 hospitals with three neurosurgeons, and 37 hospitals with four or more neurosurgeons, for a total of 422 neurosurgeons. There were 21 hospitals with no neurologists on staff, 25 hospitals with one neurologist, 30 hospitals with two neurologists, 29 hospitals with three neurologists, and 32 hospitals with four or more neurologists, for a total of 349 neurologists. There were 99 hospitals with no radiologists on staff, 28 hospitals with one radiologist, 14 hospitals with two radiologists, seven hospitals with three radiologists, and one hospital with four or more radiologists, for a total of 81 radiologists. Thirteen hospitals were found to have other departments involved in the care of patients with acute stroke: the rehabilitation department at seven hospitals (a total of 16 specialists), the emergency department at four hospitals (a total of 21 specialists), and the internal medicine at two hospitals (a total of five specialists).

The healthcare workforce involved in hemorrhagic stroke care

For subarachnoid hemorrhage with ICD code I60, there were 30 hospitals with no neurosurgeons who could perform emergency craniotomies for cerebral aneurysm clipping, 30 hospitals with one neurosurgeon, 42 hospitals with two neurosurgeons, 35 hospitals with three neurosurgeons, and 12 hospitals with four or more neurosurgeons, for a total of 271 neurosurgeons. When categorizing this workforce by the level based on the ASQAP, the majority was concentrated in level 1 healthcare institutions (**Fig. 1A and B**). Ten of the 30 hospitals with no surgical workforce were level 1 healthcare institutions. There were no specialists other than neurosurgeons who could perform emergency surgery for patients with subarachnoid hemorrhage.

For cerebral hemorrhage with ICD codes I61 and I62, there were eight hospitals with no neurosurgeons on staff who could perform craniotomy or craniectomy to remove the hematoma, 19 with one neurosurgeon, 34 hospitals with two neurosurgeons, 42 hospitals with three neurosurgeons, 21 hospitals with four, and 25 hospitals with five or more neurosurgeons, for a total of 441 neurosurgeons. When categorizing this workforce by the ASQAP hospital level, the majority was concentrated in level 1 healthcare institutions (382/441, 87.1%). Two of the eight hospitals with no surgical workforce were level 1 healthcare institutions (**Fig. 1C and D**). There were no specialists other than neurosurgeons who could perform emergency surgery for patients with intracranial hemorrhage.

For intracranial hemorrhages with ICD codes I60 through I62, 25 hospitals with no neurosurgeons on staff could perform cerebrovascular interventions, including coil embolization, cerebral arteriovenous malformation embolization, and middle

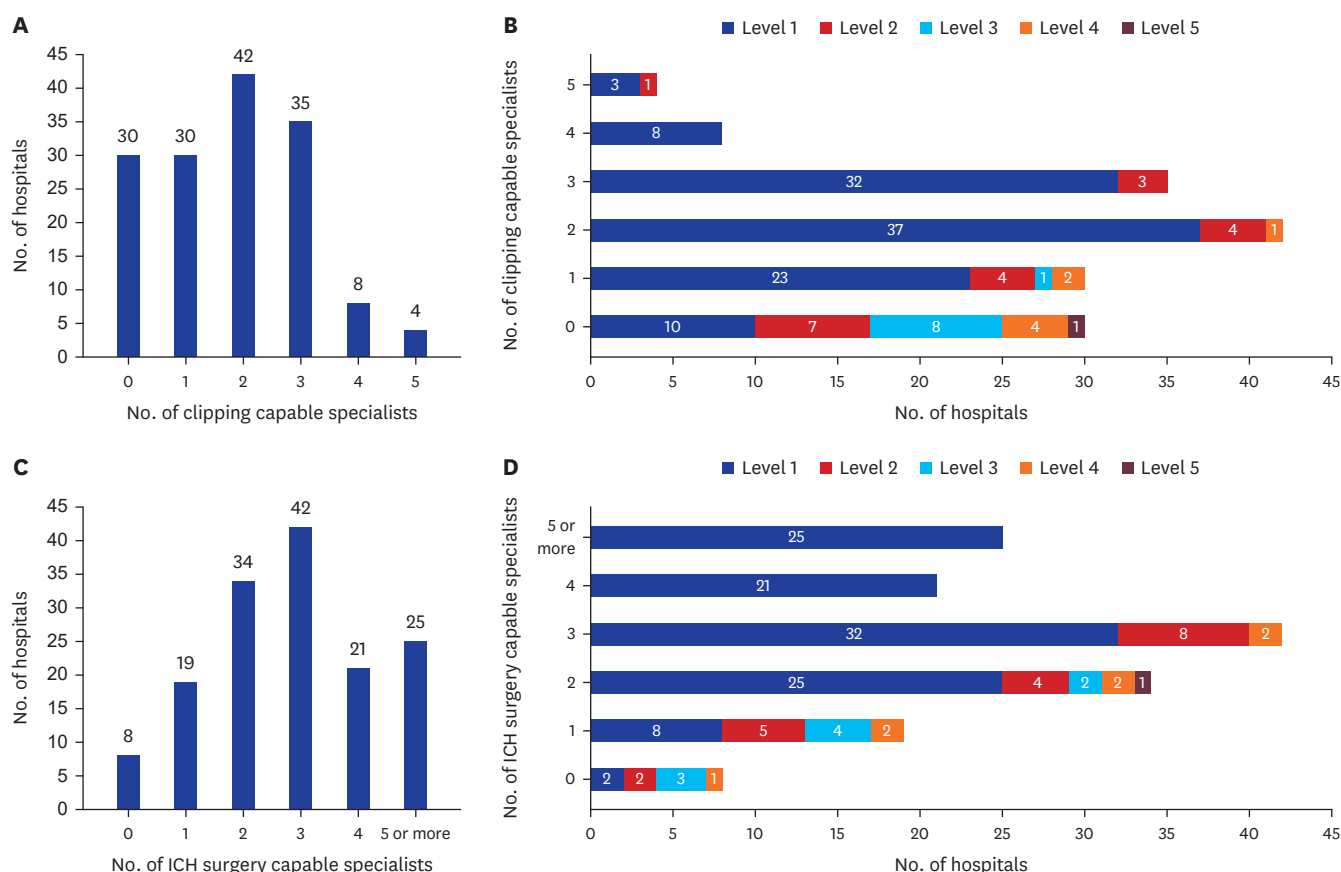


Fig. 1. Current status of neurosurgeons capable of performing emergency surgery for acute hemorrhagic stroke. **(A)** Hospitals by the number of specialists on staff capable of performing cerebral aneurysm clipping for aneurysmal subarachnoid hemorrhage (I60). **(B)** Distribution of specialists on staff capable of performing cerebral aneurysm clipping at the level of the healthcare institution. **(C)** Hospitals by the number of specialists on staff capable of performing craniotomy or craniectomy to remove the hematoma for intracerebral hemorrhage (I61-62). **(D)** Distribution of specialists on staff capable of performing craniotomy or craniectomy to remove the hematoma by the level of healthcare institution.

meningeal artery embolization, 25 hospitals with one neurosurgeon, 58 hospitals with two neurosurgeons, 27 hospitals with three neurosurgeons, nine hospitals with four neurosurgeons, and five hospitals with five or more neurosurgeons, for a total of 285 neurosurgeons. There were 142 hospitals with no neurologists on staff, four hospitals with one neurologist, and three hospitals with two neurologists, for a total of 10 neurologists. There were 124 hospitals with no radiologists on staff, 15 hospitals with one radiologist, and 10 hospitals with two radiologists, for a total of 35 radiologists. Neurosurgeons were mostly concentrated in level 1 healthcare institutions (246/285, 86.3%), and neurologists and radiologists with cerebrovascular intervention capabilities were all working in level 1 healthcare institutions (Fig. 2).

The healthcare workforce involved in ischemic stroke care

For acute cerebral infarction with ICD code I63, there were 34 hospitals with no neurosurgeons on staff who could perform cerebrovascular interventions such as intra-arterial (IA) thrombectomy, 30 hospitals with one neurosurgeon, 49 hospitals with two neurosurgeons, 23 hospitals with three neurosurgeons, nine hospitals with four, and four hospitals with five or more neurosurgeons, for a total of 255 neurosurgeons. There were 115 hospitals with no neurologists on staff, 24 hospitals with one neurologist, and 10 hospitals with two neurologists, for a total of 44 neurologists. There were 12 hospitals with no radiologists

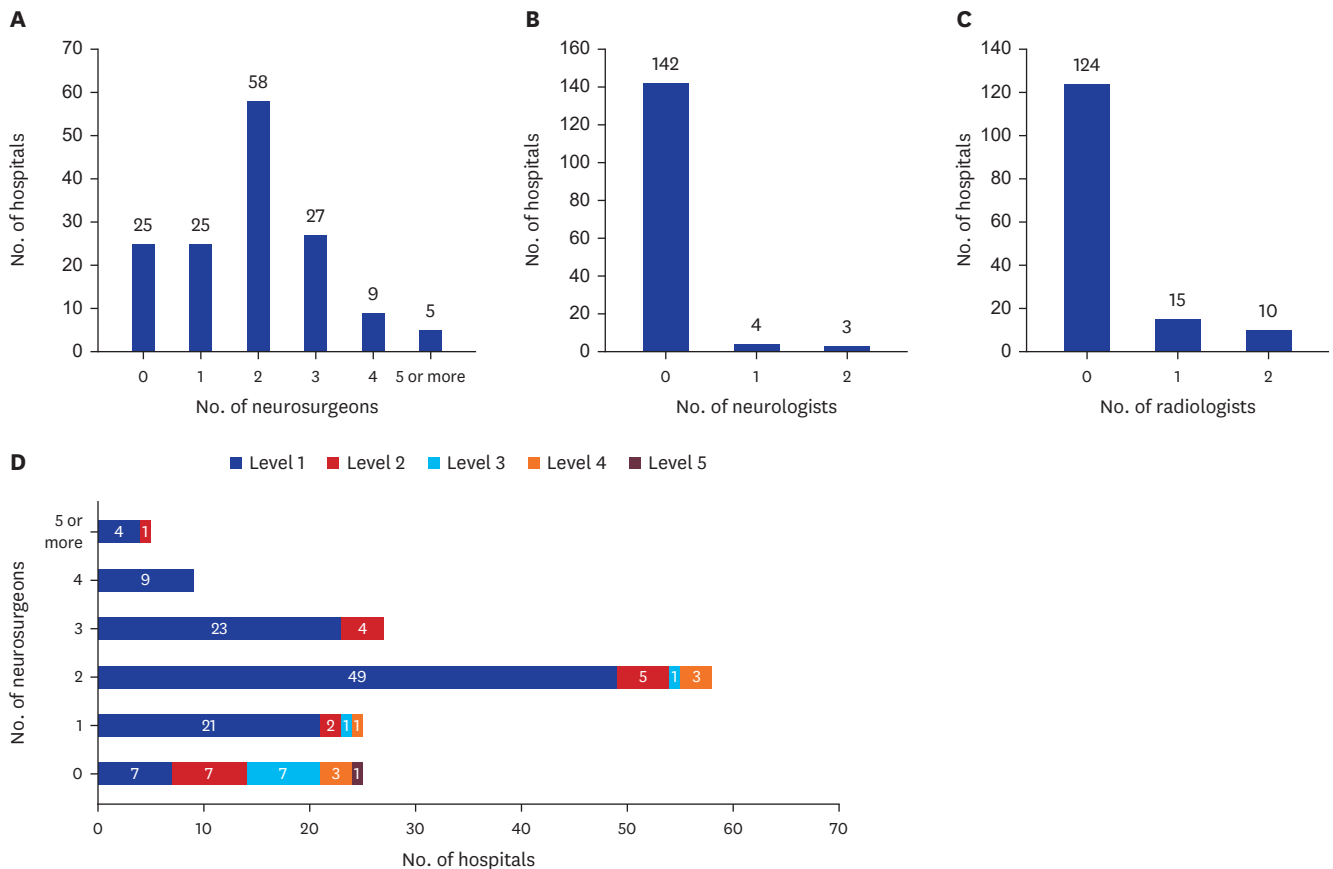


Fig. 2. Current status of specialists capable of performing cerebrovascular interventions for acute hemorrhagic stroke. (A) Hospitals by the number of neurosurgeons on staff. (B) Hospitals by the number of neurologists on staff. (C) Hospitals by the number of radiologists on staff. (D) Distribution of neurosurgeons on staff by the level of healthcare institution.

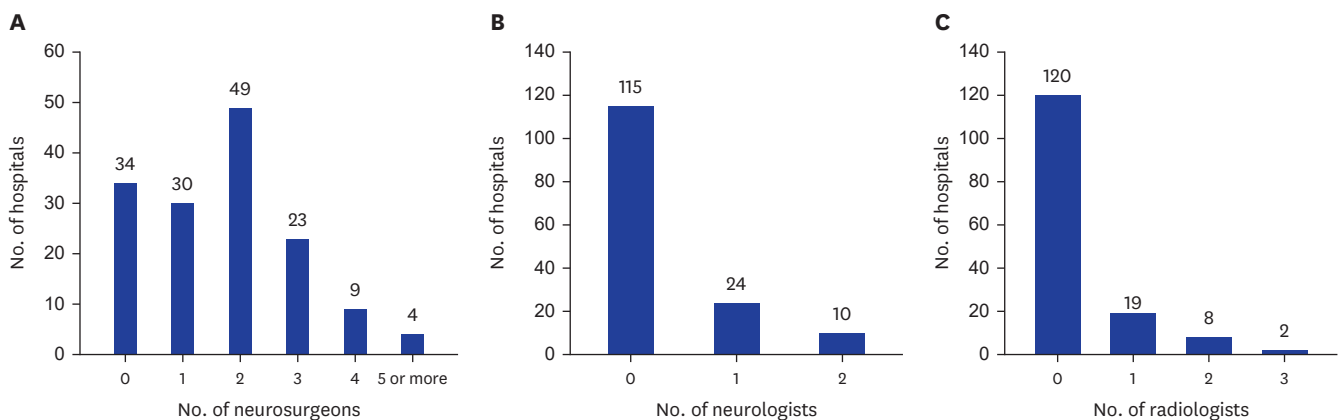


Fig. 3. Current status of specialists capable of performing cerebrovascular interventions for acute cerebral infarction. (A) Hospitals by the number of neurosurgeons on staff. (B) Hospitals by the number of neurologists on staff. (C) Hospitals by the number of radiologists on staff.

on staff, 19 hospitals with one radiologist, eight hospitals with two radiologists, and two hospitals with three radiologists, for a total of 41 radiologists. Neurosurgeons and neurologists were mostly concentrated in level 1 healthcare institutions (220/255, 86.3% vs. 39/41, 95.1%), and radiologists with cerebrovascular intervention capabilities were all working in level 1 healthcare institutions (Fig. 3).

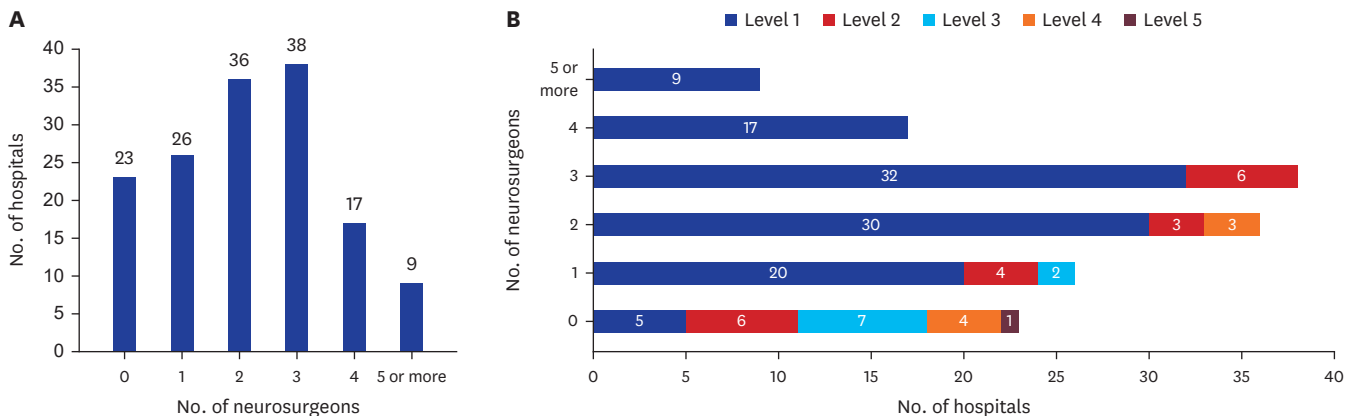


Fig. 4. Current status of neurosurgeons capable of performing surgical treatments for acute cerebral infarction. **(A)** Hospitals by the number of neurosurgeons on staff capable of performing craniotomy or cerebral artery bypass for acute cerebral infarction (I63). **(B)** Distribution of neurosurgeons on staff capable of performing surgical treatments for acute cerebral infarction by the level of healthcare institution.

For acute cerebral infarction with ICD code I63, there were 23 hospitals with no neurosurgeons on staff who could perform cerebral artery bypass or decompressive craniectomy, 26 with one neurosurgeon, 36 hospitals with two neurosurgeons, 38 hospitals with three neurosurgeons, 17 hospitals with four, and nine hospitals with five or more neurosurgeons, for a total of 332 neurosurgeons. This workforce was mostly concentrated in level 1 healthcare institutions. Five of the 23 hospitals with no surgical workforce were level 1 healthcare institutions (Fig. 4). There were no specialists other than neurosurgeons who could perform emergency surgery for patients with cerebral infarction.

Current status of acute stroke care

For intracranial hemorrhage with ICD codes I60 through I62, treatment decisions were most commonly made by the department of neurosurgery alone at 106 hospitals (71.1%), followed by the departments of neurosurgery and neurology in consultation at 25 hospitals (16.8%).

For patients with ICD code I63, decisions regarding intravenous thrombolysis were most commonly made by the department of neurology alone at 89 hospitals (59.7%), followed by the departments of neurosurgery and neurology in consultation at 32 hospitals (21.5%) and the department of neurosurgery alone at 28 hospitals (18.8%). For this disease, decisions regarding IA thrombectomy were most commonly made by the departments of neurosurgery and neurology in consultation at 52 hospitals (34.9%), followed by the departments of neurosurgery alone in consultation at 43 hospitals (28.9%), and the department of neurology alone at 26 hospitals (17.4%) (Fig. 5).

For intracranial hemorrhage with ICD codes I60 through I62, patients were managed after surgical treatments or cerebrovascular interventions by the department of neurosurgery alone at 144 hospitals (96.6%) and 125 hospitals (83.9%), respectively, with the department of neurosurgery making an overwhelming majority of contributions to care. Patients with ICD code I63 were managed after IA thrombectomy by the department of neurosurgery alone at 56 hospitals (37.6%) and the department of neurology alone at 54 hospitals (36.2%). For this disease, patients were managed after surgical treatments such as craniotomy or arterial bypass by the department of neurosurgery alone at 132 hospitals (88.6%), with the department of neurosurgery making an overwhelming majority of contributions to care (Fig. 6).

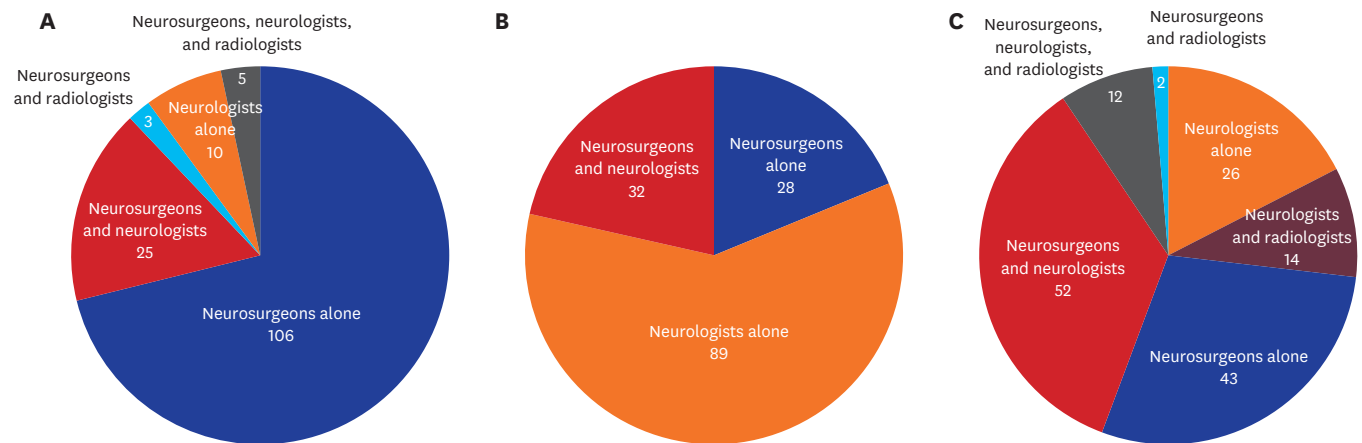


Fig. 5. Decision-makers for disease-specific treatments. **(A)** Decision-makers for treatment of intracranial hemorrhage (I60-I62). **(B)** Decision-makers for intravenous thrombolysis for patients with acute cerebral infarction. **(C)** Decision-makers for intra-arterial thrombectomy.

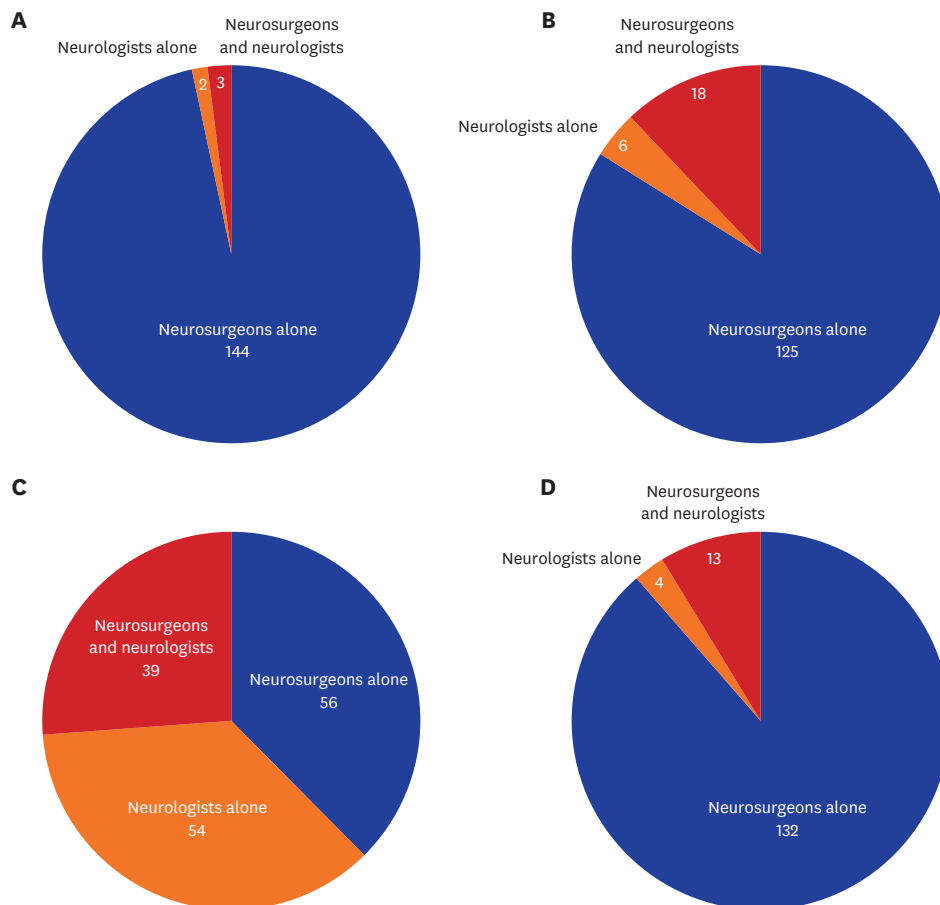


Fig. 6. Patient management after the treatment of acute stroke. **(A)** Patient management after surgical treatments for intracranial hemorrhage (ICD codes I60-I62). **(B)** Patient management after cerebrovascular interventions for intracranial hemorrhage (ICD codes I60-I62). **(C)** Patient management after intra-arterial thrombectomy for patients with ICD code I63. **(D)** Patient management after surgical treatments such as craniotomy or arterial bypass for patients with ICD code I63.

ICD = International Classification of Diseases.

Current status of care related to emergency surgeries or interventions

There was a wide variation by the department in the monthly frequency of a specialist being on duty (6:00 p.m. that day to 8:00 a.m. the next day, including staying on-call) to perform emergency surgery or cerebrovascular intervention for patients with acute stroke. It was the most frequent in the department of neurosurgery, with 79 hospitals (53.0%) reporting their neurosurgeons being on duty two weeks per month, followed by 16.1% with four times per month (daily), 14.8% with one week per month, and 5.4% with seven days per month or less. Neurologists were also reported to be on duty two weeks per month at 27.5% and four times per month at 2%. Radiologists were reported to be on duty two weeks per month at 10.7% and four times per month at 5.4%. There were 12 hospitals (8.1%) with no neurosurgeons being on duty, 81 hospitals (54.4%) with no neurologists being on duty, and 116 hospitals (77.9%) with no radiologists on duty (Fig. 7A). The frequency of monthly attendances at the hospital for emergency procedures or surgeries outside of regular working hours (6:00 p.m. that day to 8:00 a.m. the next day) was averaged over the survey period. Neurosurgeons were most likely to attend the hospital outside of regular working hours, with 50 hospitals (33.6%) reporting 1–3 times per month, followed by 30.2% with 4–7 times per month and 20.1% with 8–15 times per month. Although the number of hospitals was small, neurologists and radiologists were most likely to attend the hospital outside of regular working hours 1–3 times per month, followed by 4–7 times per month (Fig. 7B). As for outpatient treatments scheduled for the next day after an emergency surgery or cerebrovascular intervention, neurosurgeons at 135 hospitals (90.6%) and neurologists at 59 hospitals (39.6%) performed outpatient treatments themselves after an emergency surgery or procedure (Fig. 7C).

DISCUSSION

In terms of the regional distribution of hospitals, there were 51 in the Seoul metropolitan area, 46 in regional metropolitan areas, and 52 in other regions, with an even distribution of acute stroke hospitals across regions and a similar proportion of hospitals with a number of beds ranging from 100 to 1,000. However, the healthcare workforce treating acute stroke varies by institution. For hemorrhagic or ischemic strokes requiring surgical or interventional treatment, such a surgical or interventional procedure is the definitive treatment. The specialists in neurosurgery, neurology, or radiology who can provide this definitive treatment are mostly clustered in level 1 healthcare institutions. Furthermore, even level 1 healthcare institutions may not have neurosurgeons on staff to provide surgical treatment. Patients with stroke who require urgent surgical treatment in hospitals without surgeons capable of performing surgeries or interventions may not receive any treatment, or they may miss the golden hours for treatment while being transferred to another hospital.⁸ Furthermore, the prognosis of patients with hemorrhagic stroke depends on the presence of surgeons skilled in surgical treatments or cerebrovascular interventions in the hospital.^{9,10} Given this workforce distribution, the current ASQAP criteria may require significant revisions in the workforce area. Under the current criteria, hospitals other than level 1 healthcare institutions are not considered capable of treating stroke. There were even level 1 healthcare institutions with no neurosurgeons on staff to provide surgical treatments. The assessment criteria should include an adequate number of specialists on staff who can perform emergency surgery or interventions to ensure that hospitals treating acute strokes are able to provide true definitive care.

The decision-makers for the initial treatment of patients with acute stroke vary by disease. As hemorrhagic strokes were relatively more likely to require surgical treatment, the decision

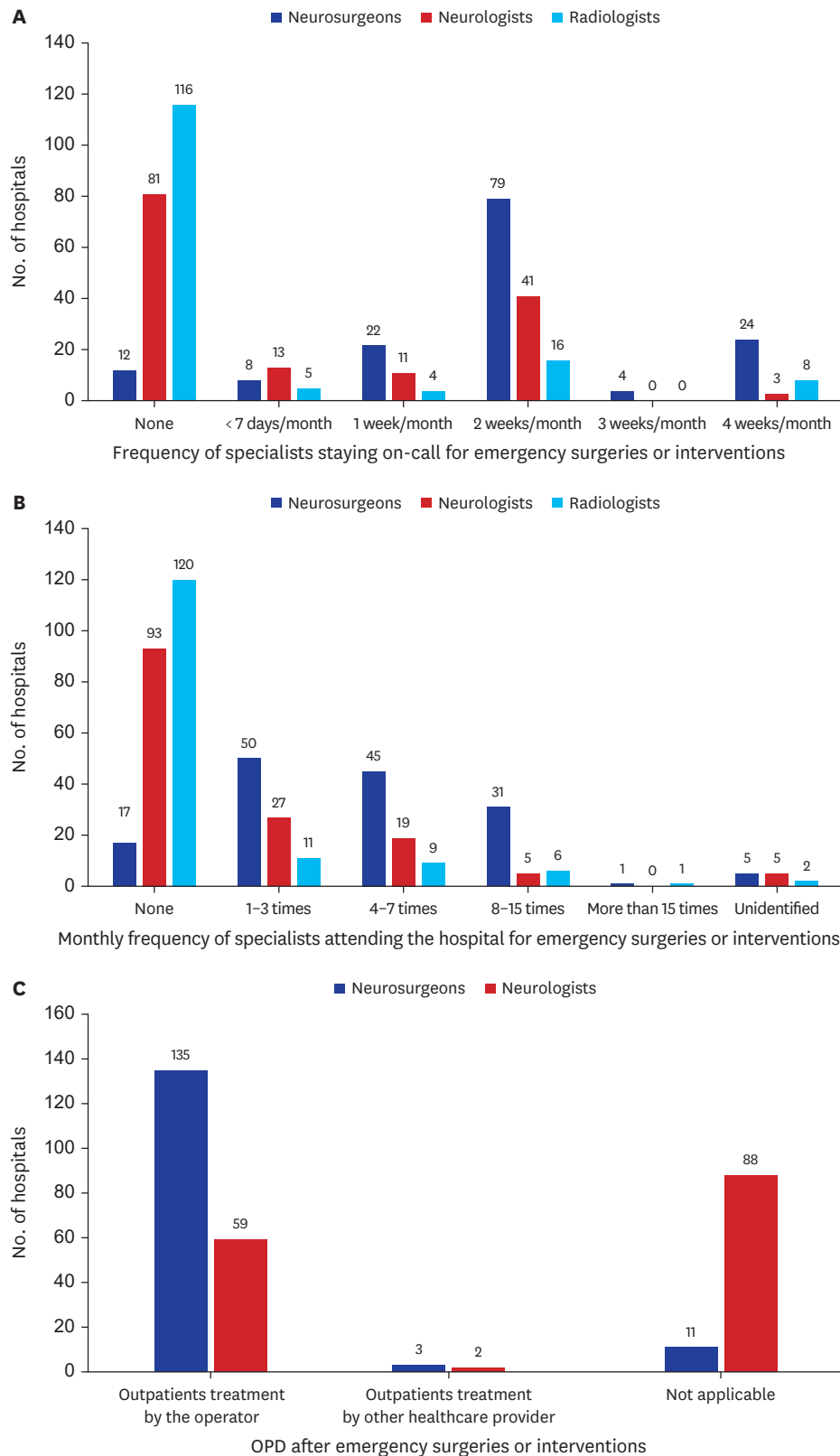


Fig. 7. Current status of care related to emergency surgeries or interventions for acute stroke patients. **(A)** Frequency of specialists staying on-call for emergency surgeries or interventions for acute stroke patients. **(B)** Monthly frequency of specialists attending the hospital for emergency surgeries or interventions outside of regular working hours. **(C)** Outpatient treatments after emergency surgeries or interventions for acute stroke patients.

was often made by neurosurgeons alone. Since the evidence for IA thrombectomy in ischemic stroke was established in 2015, the decision of whether or not to perform IA thrombectomy has become more dependent on the judgment of the specialist actually performing the surgery, in addition to neurology.¹¹ This increased reliance on the judgment of the surgical specialist may explain the high contribution of neurosurgeons in determining the treatment of ischemic stroke, a condition that neurologists typically treat.¹² The contribution of neurosurgeons to ischemic stroke care may also have been reported to be high, given that surgical treatment also contributes to patient recovery. While radiologists also contribute to cerebrovascular interventions, the number of specialists performing the procedures was small, with a limited number of institutions, leading to their low contribution to the decision-making process for actual treatments based on national data. Intravenous thrombolysis, on the other hand, involves administering thrombolytic drugs intravenously rather than performing an invasive procedure on the patient, which is similar to administering a common injection. When performing intravenous thrombolysis, the specialist is responsible for assessing the medical history and conducting a neurological examination to determine the suitability of using injectable medications as well as the doses. Therefore, any specialist who can perform a neurological exam and prescribe injectable medications can do it, including neurosurgeons who treat cerebrovascular diseases. Previously, it was mainly handled by neurologists as it was not a surgical treatment. However, recently, the role of interventional and surgical treatments has been emphasized, making these specialists contribute more and more to the initial treatment decision.¹² For intravenous thrombolysis, in particular, neurosurgeons, unlike radiologists, are naturally contributing to the decision to use intravenous thrombolysis as an initial treatment due to their role in directly managing patients in clinical practice.

In the emergency surgical treatment of acute stroke, neurosurgeons provided the overwhelming majority of care for patients after acute treatment, regardless of the disease. It seems to be a natural consequence of the fact that most of these patients require intensive care after surgery, which is the domain of neurosurgeons.¹³ As ischemic stroke care was traditionally considered the domain of neurologists, the role of the neurologist appears to remain significant. However, since IA thrombectomy was established as a treatment for ischemic stroke, neurologists and neurosurgeons have been found to contribute in similar proportions. Furthermore, since IA thrombectomy is an invasive procedure, the increasing contribution of neurosurgeons is likely attributed to the need to prepare for possible complications or adverse outcomes in the acute postoperative period that may require surgical treatment.

There was a wide disparity in the number of specialists staying on-call for emergency surgery or intervention for patients with acute stroke, as well as in the number of specialists attending the hospital outside of regular working hours to perform emergency surgery or intervention, with neurosurgeons accounting for the majority of such specialists. The predominance of neurosurgeons in these roles may be due to the fact that neurosurgeons are the only specialists who can provide emergency interventions or surgeries for patients with acute stroke. While neurologists and radiologists can also perform emergency interventions, they are few. They cannot perform emergency surgeries, leaving neurosurgeons to dominate the workforce when it comes to definitive treatments, such as emergency surgeries and interventions. There were 95 (63.8%) hospitals where neurosurgeons attended the hospital outside of normal working hours 1–7 times per month for emergency surgeries or procedures, indicating a high frequency of neurosurgeons attending the hospital outside of normal

working hours. This study also found that most scheduled outpatient visits immediately following emergency surgery were performed by the surgeons themselves. In the end, neurosurgeons performing the majority of emergency surgeries or interventions were found to be overworked and overburdened. There should be a sufficient number of neurosurgeons who can perform emergency surgeries and interventions, i.e., the definitive treatment of acute stroke, to balance the workload.

A limitation of this study was that while the survey was conducted on hospitals included in the Ninth ASQAP, 83 (30.4%) of the 232 hospitals did not respond to the survey due to various circumstances. It will be necessary to survey the status of care through on-site visits as well as online surveys to gather opinions and develop realistic self-help measures. However, of a total of 132 hospitals classified as level 1 healthcare institutions in the Ninth ASQAP, 113 (84.9%) have responded to the survey, which is considered to be sufficient to reflect the reality of the workforce and care related to acute stroke under the current assessment indices. In addition, the staffing situation at each hospital was assessed by collecting data solely on the number of physicians employed in this survey. However, since each hospital operates its acute stroke care workforce according to its individual circumstances, it was found that there is considerable variation in staffing arrangements across hospitals. A more detailed structural approach, if undertaken alongside this survey, might have yielded more specific and comprehensive results.

In conclusion, the survey results showed that the current status of the healthcare workforce providing the definitive treatment, such as IA thrombectomy for cerebral infarction or cerebral aneurysm clipping for subarachnoid hemorrhage, and the current status of care for acute stroke are rarely reflected in the current ASQAP. This lack of reflection may have been due to the lack of consideration of the workforce and care related to hemorrhagic stroke, which is a critical component of acute stroke. Despite being an ASQAP level 1 healthcare institution, some hospitals do not have a sufficient workforce to perform the definitive treatment, suggesting the need to establish appropriate assessment criteria for the workforce. In addition, as the intensity of work for healthcare workers providing the definitive treatment of acute stroke has been found to be considerable, ways to keep the intensity of work at an appropriate level will also be required.

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