Table 10. Associations between total comprehensive stroke care (CSC) scores separated into quintiles (Q1: 4–12, Q2: 13–14, Q3: 15–17, Q4: 18, Q5: 19–23) and in-hospital mortality of patients after all types of stroke (a), ischemic stroke (b), intracerebral hemorrhage (ICH) (c), and subarachnoid hemorrhage (SAH) (d), model 1: after adjustment for age, sex, and initial level of consciousness; and model 2: after adjustment for age, sex, initial level of consciousness, and incidence of hypertension, hyperlipidemia, and diabetes mellitus.

		Model 1					Model 2				
Type of Stroke	Quintile	OR	P value	95% CI		P for trend	OR	P value	95% CI		P for trend
Whole Population (n = 53,170)	Q2	0.87	0.077	0.74	1.02	0.005	0.88	0.119	0.75	1.03	0.013
	Q3	0.84	0.023	0.72	0.98		0.86	0.045	0.74	1.00	
	Q4	0.87	0.115	0.74	1.03		0.91	0.254	0.77	1.07	
	Q5	0.73	0.003	0.60	0.90		0.74	0.004	0.60	0.91	
Ischemic Stroke (n = 32,671)	Q2	0.90	0.278	0.75	1.08	0.003	0.92	0.356	0.77	1.10	0.005
	Q3	0.79	0.008	0.66	0.94		0.81	0.015	0.68	0.96	
	Q4	0.84	0.097	0.69	1.03		0.86	0.131	0.71	1.05	
	Q5	0.71	0.006	0.56	0.91		0.73	0.01	0.58	0.93	
ICH (n = 15,699)	Q2	0.76	0.015	0.62	0.95	<0.001	0.79	0.034	0.63	0.98	0.053
	Q3	0.82	0.058	0.67	1.01		0.83	0.083	0.68	1.02	
	Q4	0.79	0.039	0.63	0.99		0.82	0.099	0.65	1.04	
	Q5	0.76	0.050	0.58	1.00		0.76	0.051	0.58	1.00	
SAH (n = 4,934)	Q2	1.04	0.814	0.78	1.38	0.137	1.10	0.568	0.80	1.51	0.601
	Q3	0.92	0.524	0.71	1.19		0.96	0.767	0.71	1.28	
	Q4	1.00	0.975	0.75	1.34		1.22	0.232	0.88	1.68	
	Q5	0.68	0.043	0.47	0.99		0.73	0.126	0.48	1.09	

ICH, intracerebral hemorrhage; SAH, subarachnoid hemorrhage.
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not include all worthwhile items related to CSC. These items were appropriately modified from the original American version [2] in consideration of the medical, social, and logistical differences between the U.S. and Japan. For example, most cerebrovascular surgeries, including carotid endarterectomy and neurointervention, are performed by neurosurgeons rather than vascular surgeons or neuroradiologists. At the beginning of this project, a survey including the 25 components recommended by the Brain Attack Coalition in 2005 was created after a review of the literature on comprehensive stroke centers and a thorough discussion by an expert panel. Some recommended items such as availability of ventriculostomy were excluded from our questionnaire merely for simplicity, and thus to increase the response rate of the survey, since they seemed to be identical to recommendations of the board-certified neurosurgeons of Japan. On the other hand, some items such as transesophageal echocardiography were excluded because of the expected very low usage of this examination. According to the Japanese Stroke Databank 2009, for example, transesophageal echocardiography was performed for only 5.4% of the 34,417 acute ischemic stroke

Table 11. Impact of processes of stroke care on in-hospital mortality after all types of stroke.

	OR	P value	95% CI
Monitoring (%)	1.04	0.53	0.92–1.17
Early rehabilitation (%)	1.15	0.352	0.86–1.52
Admission to SCU (%)	0.87	0.039	0.76–0.99
Acute stroke team	0.88	0.029	0.79–0.99
Organized care index*	0.93	0.031	0.86–0.99
Existence of t-PA protocol (%)	0.88	0.295	0.69–1.12
Number of t-PA cases/year (mean)	1.00	0.203	0.99–1.00
Number of acute stroke patients/staff physician (mean)	0.999	0.012	0.998–1.000

*The organized stroke care index was created to represent different levels of access to organized stroke care ranging from 0 to 3 as determined by the presence of early rehabilitation, acute stroke team assessment, and admission to a stroke unit based on the report of Saposnik et al. (2009).
SCU, stroke care unit; t-PA, tissue plasminogen activator.
doi:10.1371/journal.pone.0096819.t011

Table 12. Impact of processes of stroke care on in-hospital mortality after ischemic stroke.

	OR	P value	95% CI
Monitoring (%)	0.98	0.738	0.85–1.12
Early rehabilitation (%)	1.09	0.615	0.78–1.52
Admission to SCU (%)	0.91	0.218	0.78–1.06
Acute stroke team	0.85	0.016	0.74–0.97
Organized care index*	0.92	0.055	0.85–1.00
Existence of t-PA protocol (%)	0.82	0.158	0.61–1.08
Number of t-PA cases/year (mean)	0.99	0.132	0.98–1.00
Number of acute stroke patients/staff physician (mean)	0.999	0.047	0.998–1.000

*The organized stroke care index was created to represent different levels of access to organized stroke care ranging from 0 to 3 as determined by the presence of early rehabilitation, acute stroke team assessment, and admission to a stroke unit based on the report of Saposnik et al. (2009).
SCU, stroke care unit; t-PA, tissue plasminogen activator.
doi:10.1371/journal.pone.0096819.t012

Table 13. Impact of processes of stroke care on in-hospital mortality after intracerebral hemorrhage.

	OR	P value	95% CI
Monitoring (%)	1.12	0.177	0.95–1.32
Early rehabilitation (%)	1.39	0.091	0.95–2.03
Hospitalization for SCU (%)	0.84	0.048	0.70–1.00
Acute stroke team	0.90	0.194	0.77–1.05
Organized care index*	0.93	0.163	0.85–1.03
Existence of t-PA protocol (%)	0.84	0.314	0.60–1.18
Number of t-PA cases/year (mean)	1.00	0.313	0.99–1.00
Number of acute stroke patients/staff physician (mean)	0.999	0.043	0.998–1.000

*The organized stroke care index was created to represent different levels of access to organized stroke care ranging from 0 to 3 as determined by the presence of early rehabilitation, acute stroke team assessment, and admission to a stroke unit based on the report of Saposnik et al. (2009).
SCU, stroke care unit; t-PA, tissue plasminogen activator.
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Table 14. Impact of processes of stroke care on in-hospital mortality after subarachnoid hemorrhage.

	OR	P value	95% CI
Monitoring (%)	1.04	0.737	0.84–1.28
Early rehabilitation (%)	1.02	0.945	0.63–1.64
Admission to SCU (%)	0.79	0.039	0.63–0.99
Acute stroke team	0.85	0.101	0.69–1.03
Organized care index*	0.88	0.034	0.78–0.99
Existence of t-PA protocol (%)	1.09	0.732	0.66–1.81
Number of t-PA cases/year (mean)	1.00	0.456	0.98–1.01
Number of acute stroke patients/staff physician (mean)	0.998	0.006	0.997–1.000

*The organized stroke care index was created to represent different levels of access to organized stroke care ranging from 0 to 3 as determined by the presence of early rehabilitation, acute stroke team assessment, and admission to a stroke unit based on the report of Saposnik et al. (2009).
SCU, stroke care unit; t-PA, tissue plasminogen activator.
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patients in a real-world situation. The impact of this examination on the mortality rates of this study would be difficult to evaluate because of low usage. All 25 components of the questionnaire are shown in the appendix. Second, discharge data obtained from the Japanese DPC-based Payment System lacks important information, such as post-discharge data and an NIHSS or GCS score as an index of stroke severity at admission. Although the Japan Coma Scale proved to be a powerful independent predictor of mortality after all types of stroke, further study is necessary to validate the results of the present study with another indicator of stroke severity, such as the NIHSS or GCS. This can be done separately or in combination with a validation data set (the estimated data volume in the J-ASPECT 2013 is more than 80,000 cases that will be available in 2013). Third, there is an inherent risk of information bias when evaluating data obtained by self-assessment. Moreover, hospitals actively working to improve stroke care may have been more likely to respond to the questionnaire. Admittedly, the participation rate of DPC data collection of the J-ASPECT study was relatively low. The participation rates were 19.4% of the 1,369 certified training institutions of the Japan Neurosurgical Society, and 35.4% of the 749 hospitals that responded to the institutional survey. However, the institutes that participated in the present study tended to have more beds and more stroke cases than average. This suggests that the hospitals that were more active in stroke care and potentially eligible for CSC participated in this study. Therefore, the present results may not generalize to non-participating hospitals. External validation greatly increases the reliability of self-assessment data. Accordingly, we plan to validate the information regarding hospital characteristics and outcomes by using a small sample set from the 2010 validation cohort of the present study. Since the number of participating hospitals in this study is increasing every year, we are planning to evaluate how the validity and reliability of the CSC score in predicting stroke patient mortality changes when weighting factors are applied to the recommended items, stroke type, and severity. Through annual evaluations, we aim to achieve higher predictive validity and responsiveness to establish the usefulness of the CSC score. Fourth, we assigned 1 point if the hospital met each recommended item for CSC. However, this equal weight assumption is probably not valid since some components were not significant on subgroup analysis. Although some associations between individual CSC components and mortality achieved significance, several did not but were very close to significant, based on the confidence intervals. These non-significant trends are telling and suggest that the subgroup component analyses were underpowered and thus prone to type 2 error. In addition, we performed multiple comparisons for each stroke type, and therefore, some of the secondary analyses, particularly those that evaluated the impact of stroke care procedures on in-hospital mortality, are prone to type 1 error. We need a larger sample size to validate each recommended item and appropriately weight the subscores.

Conclusions

Although patient demographics and stroke severity are important predictors of in-hospital mortality of patients with all types of stroke, CSC capacities were associated with reduced in-hospital mortality rates, with relevant aspects of care dependent on stroke type.

Supporting Information

File S1 English translation of the survey.
(DOCX)

File S2 List of the participating hospitals (J-ASPECT Study).
(DOCX)

Table S1 Japan Coma Scale for grading impaired consciousness.
(DOCX)

Table S2 The impact of total comprehensive stroke care (CSC) score on in-hospital mortality after ischemic stroke adjusted by age, sex, level of consciousness at admission, and incidence of hypertension (HTN), diabetes mellitus(DM), and hyperlipidemia(HPL).
(DOCX)

Table S3 The impact of total comprehensive stroke care (CSC) score on in-hospital mortality after intracerebral hemorrhage adjusted by age, sex, level of consciousness at admission, and incidence of hypertension (HTN), diabetes mellitus(DM), and hyperlipidemia(HPL).
(DOCX)

Table S4 The impact of total comprehensive stroke care (CSC) score on in-hospital mortality after subarachnoid hemorrhage adjusted by age, sex, level of consciousness at admission, and incidence of hypertension (HTN), diabetes mellitus(DM), and hyperlipidemia(HPL).
(DOCX)

Acknowledgments

The names of the participating 265 hospitals are listed in the File S2. We thank Drs. Manabu Hasegawa, Shunichi Fukuhara, Hisae Mori, Takuro Nakae, and Noriaki Iwata for their helpful discussions and Ms. Arisa Ishitoko and Ai Shigemura for secretarial assistance.

Author Contributions

Conceived and designed the experiments: KI KN AK. Analyzed the data: KI KN AK. Wrote the paper: KI KN AK. Collection of data: JN KO JO YS TA S. Miyachi IN KT S. Matsuda YM AS KBI HK FN SK.

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Original Article

Cross-Sectional Survey of Workload and Burnout Among Japanese Physicians Working in Stroke Care

The Nationwide Survey of Acute Stroke Care Capacity for Proper Designation of Comprehensive Stroke Center in Japan (J-ASPECT) Study

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Background—Burnout is common among physicians and affects the quality of care. We aimed to determine the prevalence of burnout among Japanese physicians working in stroke care and evaluate personal and professional characteristics associated with burnout.

Methods and Results—A cross-sectional design was used to develop and distribute a survey to 11 211 physicians. Physician burnout was assessed using the Maslach Burnout Inventory General Survey. The predictors of burnout and the relationships among them were identified by multivariable logistic regression analysis. A total of 2724 (25.3%) physicians returned the surveys. After excluding those who were not working in stroke care or did not complete the survey appropriately, 2564 surveys were analyzed. Analysis of the participants' scores revealed that 41.1% were burned out. Multivariable analysis indicated that number of hours worked per week is positively associated with burnout. Hours slept per night, day-offs per week, years of experience, as well as income, are inversely associated with burnout. Short Form 36 mental health subscale was also inversely associated with burnout.

Conclusions—The primary risk factors for burnout are heavy workload, short sleep duration, relatively little experience, and low mental quality of life. Prospective research is required to confirm these findings and develop programs for preventing burnout. **(*Circ Cardiovasc Qual Outcomes*. 2014;7:414-422.)**

Key Words: neurosurgery ■ stroke ■ tissue plasminogen activator

Burnout is a syndrome characterized by emotional exhaustion and depersonalization, leading to decreased effectiveness at work.[1] In a recent large survey of US physicians, ≈40% of neurosurgeons were found to have experienced symptoms of burnout.[2] Another US study found that ≈40% of surgeons were burned out,[3] conditions that are both associated with medical errors.[4,5] However, limited research has been conducted into the relationship between specific demographic and practice characteristics and burnout among physicians working in stroke care, and no survey research has been conducted among Japanese physicians. Such lack of research is troubling because stroke is the fourth leading cause of death in Japan, as well as a leading cause of long-term disability.[6]

The objective of this study was to determine the prevalence of burnout among Japanese neurosurgeons and neurologists working in stroke care and evaluate the personal and professional characteristics associated with burnout among this physician population.

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WHAT IS KNOWN

- Approximately 40% of US neurosurgeons were found to have experienced symptoms of burnout.
- However, limited research has been conducted into the relationship between specific demographic and practice characteristics and burnout among physicians working in stroke care, and no survey research has been conducted among Japanese physicians.

WHAT THE STUDY ADDS

- A total of 2564 Japanese physicians working for stroke care was assessed for physician burnout using the Maslach Burnout Inventory General Survey.
- Among them, 41.1% were burned out, and the primary risk factors for burnout are heavy workload, short sleep duration, relatively little experience, and low mental quality of life. Working within a comprehensive stroke center resulted in a trend for less burnout.
- The cross-sectional nature of this study requires future confirmation to better establish causality and to test strategies to reduce burnout.

Methods

The original tasks for J-ASPECT study group expected by the government are as follows:

1. Examine the plausibility of establishing comprehensive stroke care center (CSC) in Japan and its effect.
2. Examine whether CSC can reduce the tendency of physicians to avoid practicing in rural areas because of long working hours and burnout.

We hypothesized that the centralization of stroke care physicians is one of possible solutions to stop the decreasing number of stroke care physicians in Japan, as recognized by many physicians, especially in rural area. Many physicians feel that it is really difficult to maintain the local healthcare systems for stroke care. However, there is no precise information about burnout prevalence in Japanese stroke care physicians.

Study Design

In March 2011, a cross-sectional survey was sent to 11211 physicians, among whom were all board-certified members of the Japanese Neurosurgical Society and the Societas Neurologica Japonica working throughout Japan. The survey was developed by J-ASPECT researchers based on the previous studies on physician burnout.[3,7,8] We sent the survey to a total of 10791 physicians via postal mail; however, we could not mail the questionnaire to 420 physicians in the 3 Tohoku prefectures that were affected by great Tohoku earthquake. The cover letter accompanying the survey informed the physicians that only physicians who are currently working for stroke care are eligible for the survey, that their participation was voluntary, and that their responses would remain anonymous. They were requested to return the completed survey within 8 weeks. The survey contained items that collected data on relevant demographic variables and variables related to practice patterns. (Data Supplement). This study was approved by the Institutional Review Board of the National Cerebral and Cardiovascular Center, Japan.

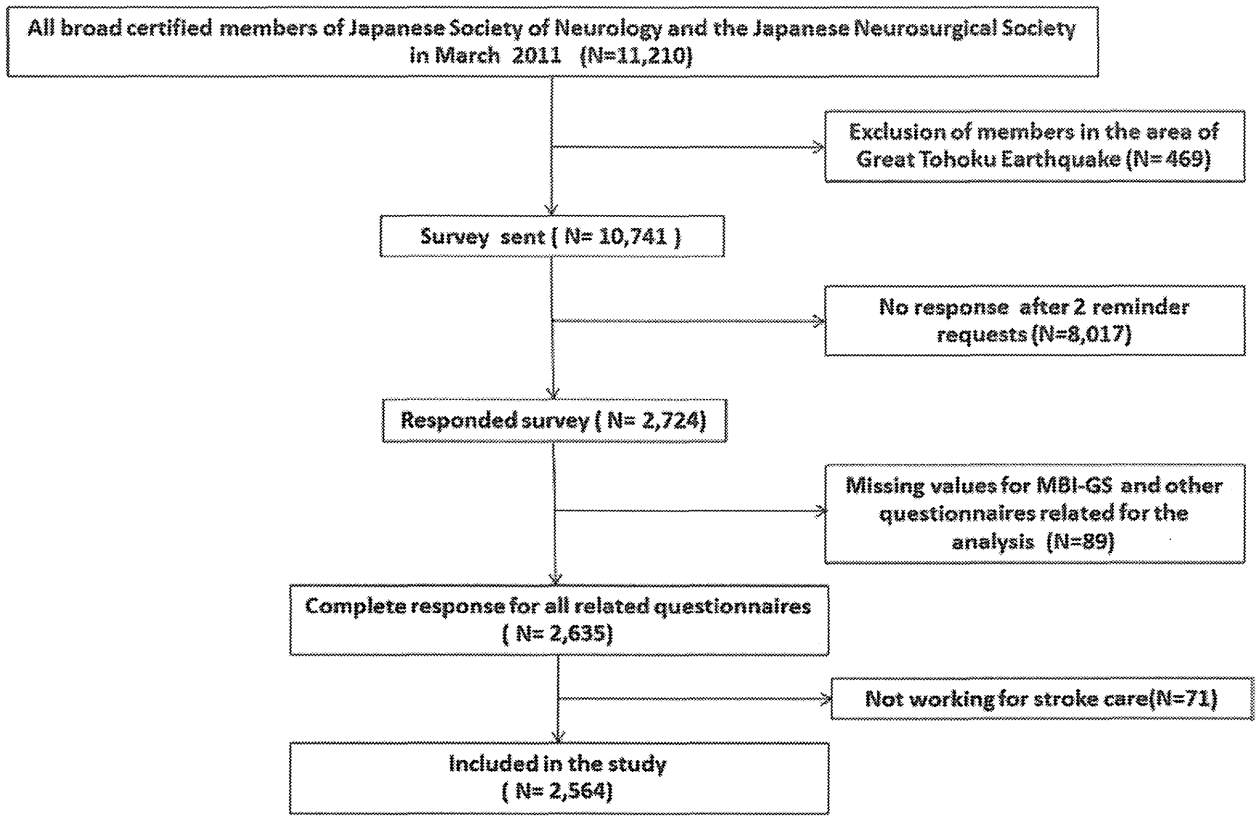


Figure 1. Flow chart of sample selection process. MBI-GS indicates Maslash Burnout Inventory General Survey.

Measurement of Burnout, Depression, and Quality of Life

Burnout among physicians was measured using the Japanese version of the Maslach Burnout Inventory General Survey (MBI-GS), a validated version of the MBI, which is currently considered the gold standard for measuring burnout.[9–11] This 16-item questionnaire[7] contains 3 subscales that evaluate what are considered the 3 major domains of burnout: exhaustion, cynicism (depersonalization), and professional efficacy. Based on the results of previous studies using the MBI-GS, which reported that a high score on the emotional exhaustion and depersonalization subscale is an indication of physician burnout,[2,11–13] and the findings from a survey of Japanese population,[14] an exhaustion score >4.0 or a cynicism (depersonalization) score >2.6 were selected as primary criteria for burnout. The criteria for severe burnout status were an exhaustion score >4.0 and either a cynicism score >2.6 or a professional efficacy score <4.17. The use of ≥1 additional criterion for severe burnout (ie, the use of exhaustion+1 criteria) was adopted because exhibiting ≥1 other symptom of burnout besides exhaustion has been reported to be a more appropriate and reliable indicator of severe burnout among the general population[15] compared with the approaches used in former studies of physician burnout.

For comparison of the study sample with the general population of Japanese workers, the MBI-GS scores of the participants were compared with the MBI-GS scores of 2843 Japanese office workers and 751 civil servants that one of our investigators had previously published.[14]

Psychological well-being was assessed using the Mental Health (MH) subscales of the Medical Outcome Study Short Form 36-Item Health Survey (SF-36), a valid and reliable instrument for measuring health-related quality of life.[16]

Statistical Analysis

Standard descriptive summary statistics were used to determine whether the participants had not been burned out, had been burned out, or had been severely burned out at the time of the survey.

Multivariable ordinal logistic regression was used to identify demographic and professional characteristics associated with burnout. Ordinal logistic regression models are used to estimate relationships between an ordinal dependent variable and a set of independent variables. An ordinal variable in this study is a variable that is categorical and ordered, burnout, and severe burnout.

Forward selection using the Akaike information criterion was used to select the best predictors. Observations from the missing data in the survey questionnaire were not incorporated in this study. The interaction (effect modification) between predictors was determined by evaluating whether the interaction terms were significant. All statistical analyses were conducted using SAS version 9.3 (SAS Institute Inc, Cary, NC) and STATA 11 (STATA Corp, College Station, TX) software, all tests were 2-sided, and all values that had a P value <0.05 were considered significant.

Results

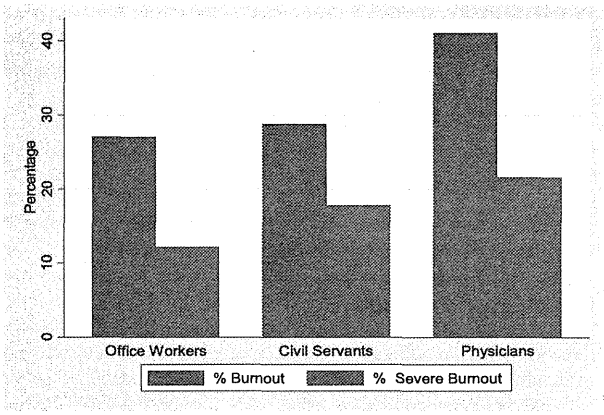
Burnout Among Japanese Physicians Working in Stroke Care

Figure 1 shows the process used to select the study participants. Of a total of 11211 board-certified neurosurgeons and neurologists practicing in any prefecture excluding the 3 prefectures affected by the Tohoku earthquake (n=469), a

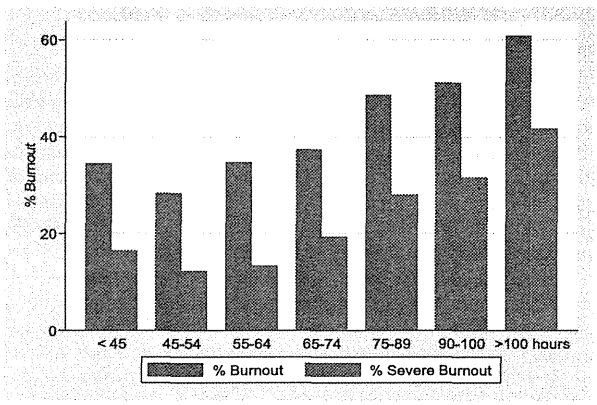
Table 1. Personal Characteristics of Study Sample by Burnout Status (n=2635)

	Not Burned Out	Mild to Moderately Burned Out	Severely Burned Out
n	1562	505	568
Percentage of sample	59.3	19.2	21.6
Male, %	92.0	93.1	90.7
Age, y	48.2 (±9.4)	46.3 (±8.9)	45.1 (±8.4)
MBI-GS scores			
Exhaustion	2.06 (±0.98)	3.72 (±1.12)	4.89 (±0.58)
Cynicism (depersonalization)	1.12 (±0.73)	2.69 (±1.16)	3.77 (±1.23)
Personal accomplishment	4.36 (±1.61)	4.17 (±1.48)	3.41 (±1.58)
No. of hours slept/night	6.07 (±1.15)	5.88 (±0.94)	5.63 (±0.94)
No. of hours worked/wk	64.3 (±15.7)	66.9 (±16.1)	72.3 (±16.6)
No. of day-offs/wk	1.19 (±0.64)	1.10 (±0.66)	0.94 (±0.59)
No. of nightshifts/mo	2.62 (±2.80)	3.01 (±2.91)	3.67 (±3.64)
No. of after-hours calls/wk	1.69 (±2.92)	2.14 (±3.15)	2.92 (±3.84)
Percentage of time spent in stroke care	44.4 (±25.9)	47.3 (±26.6)	48.5 (±26.4)
No. of t-PA cases/y	2.06 (±3.20)	2.38 (±3.58)	2.68 (±3.86)
No. of patients under care	9.11 (±6.94)	9.81 (±6.65)	10.51 (±6.62)
No. of years of experience	22.6 (±9.28)	20.8 (±8.84)	19.6 (±8.36)
Income (10000 Yen) (1000 Euro)	1488.0 (418.1) (±139.0)	1446.0 (394.0) (±131.5)	1376.8 (418.7) (±128.5)
Married, %	82.8	83.5	76.6
Children <23 y (%)	67.9	68.5	70.3
Divorced, %	1.86	1.02	2.70
SF-36 MH subscale	49.4 (±7.38)	42.5 (±7.81)	35.63 (±9.01)

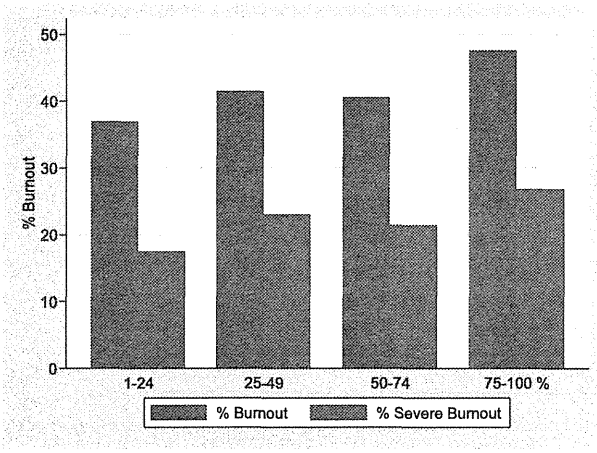
Values are means (±SDs) or numbers of participants (percentages). 10000 Yen indicates 10000$; MBI-GS, Maslash Burnout Inventory General Survey; SF-36 MH score, Short Foam 36 mental health subscale score; and t-PA, tissue-type plasminogen activator.



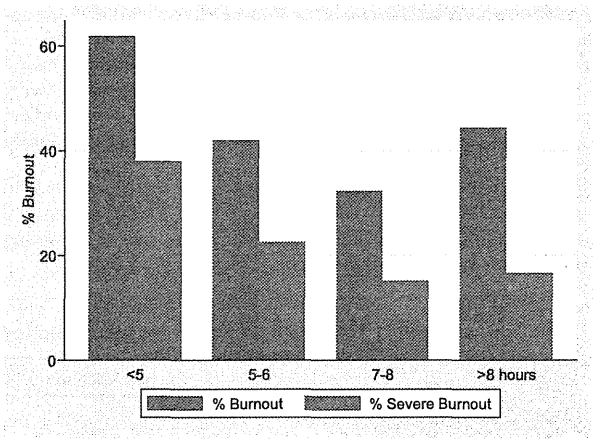
2(a) Prevalence of Burnout among Physicians and Non-Physicians



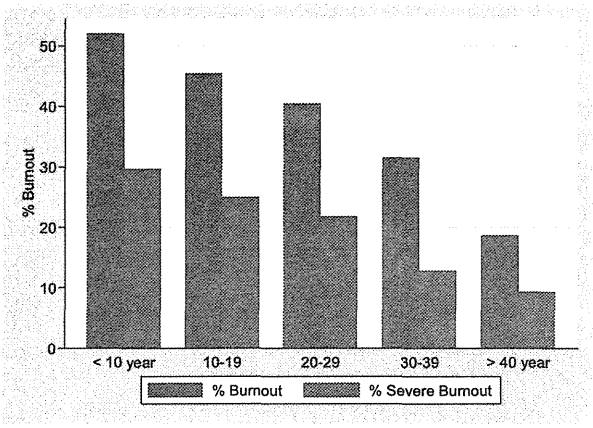
2(b) Hours Worked



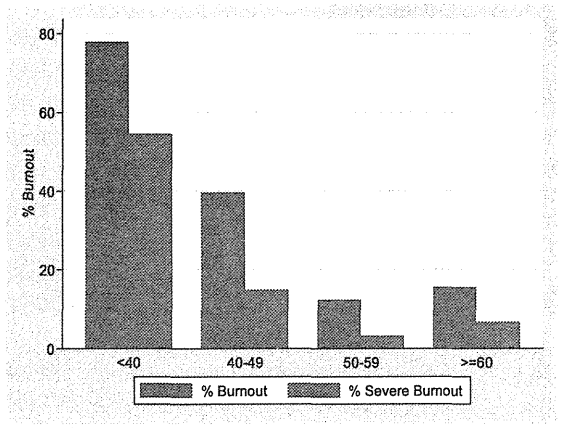
2(c) Time Spent for Stroke Care Time



2(d) Sleep Time



2(e) Experience Years



2(f) SF-36 MH Score

Figure 2. A and B, Prevalence of burnout among physicians and nonphysicians. C–F, Association between burnout and working hours, sleep duration, experience hours, and time spent for stroke scare. Prevalence of burnout was calculated for stroke care physicians (n=2635), civil servants (n=751), and office workers (n=2843). Percentage of burnout was determined by Maslash Burnout Inventory General Survey. SF-36 MH indicates Short Foam 36 mental health subscale score.

total of 2564 physicians remained for analysis. At the time that they completed this survey, the study sample had been in practice for a mean of 21.7±9.1 years (mean±SD), worked for 66.3±16.2 hours per week, slept 5.94±1.08 hours per night, were on duty for 2.91±3.04 nights per month, and received 2.00±3.21 after-hours calls per week. Among these 2564

Table 2. Univariate Ordinal Logistic Regression for Burnout

Predictors	Odds Ratio	95% CI	*P* Value
No. of hours slept/night	0.67	0.61–0.73	<0.0001
No. of hours worked/wk	1.02	1.02–1.03	<0.001
No. of day-offs/wk	0.62	0.54–0.70	<0.001
No. of nightshifts/mo	1.09	1.06–1.12	<0.001
No. of after-hours calls/wk	1.10	1.07–1.13	<0.001
Percentage of time spent in stroke care/10% of time	1.05	1.02–1.08	0.001
No. of t-PA cases/y	1.17	1.07–1.26	<0.001
No. of patients under care	1.11	1.06–1.17	<0.001
No. of years of experience	0.97	0.96–0.98	<0.001
Income (10 000 Yen) (1000 Euro)	1.00	1.00–1.00	<0.001
Extra calls/5 calls	1.60	1.40–1.83	<0.001
SF-36 MH Subscale	0.86	0.85–0.87	<0.001
Married, %	0.77	0.64–0.94	0.009
Children <23 y (%)	1.09	0.92–1.29	0.345
Divorced, %	1.20	0.68–2.13	0.529

Odds ratios were obtained from ordinal logistic regression analysis. 1 million Yen indicates 12 000 US$; % time for spent stroke, % time for stroke care/10% incremental of time; experience year, experience years/10 incremental years (experience years were approximately proportional to age, and age was omitted for the adjustment); hours worked, hours worked/10 incremental hours; income, income/1 million Yen; number of extra calls, number of extra calls after hours/5 incremental calls/wk; number of holidays, number of holidays/wk; number of nightshifts, number of nightshifts/mo; number of patients, number of patients in charge/10 incremental patients; number of t-PA cases, number of t-PA cases/5 incremental cases/y; SF-36 MH score, Short Foam 36 mental health subscale score; sleep time, sleep duration/d; and t-PA, tissue-type plasminogen activator.

physicians, 1525 (59.4%) were used at 578 teaching hospitals or CSC that were participating in a survey of CSC as part of the J-ASPECT study group. Because 3757 physicians were working at institutes participating in the J-ASPECT study in March 2011, the average response rate among active stroke care center physicians was estimated at 40.6%. Other relevant personal characteristics about the study sample are summarized in Table 1.

To investigate the possibility of selection bias, we checked the address of responders and nonresponders. The response rate was not statistically different in all 44 prefectures in this analysis (P=0.683). We also found no significant differences for age, sex, and specialty (neurologist versus neurosurgeon), burnout rate, workload per week, sleep duration per day, number of day-offs, and number of patients under care among early responders compared with late responders.

Review of the participants' MBI-GI scores indicates that 41.1% (n=1055) of the study sample was burned out and 21.8% (n=560) was severely burned out at the time of the survey (Figure 2A). Consideration of the MBI-GS scores of 2843 office workers and 751 civil servants indicates that the prevalence of burnout and severe burnout among stroke care physicians (41.1% and 21.8%, respectively) is significantly higher than that among civil servants (28.8%, P<0.001 and 17.8%, P=0.0268, respectively) and office workers (27.1%, P<0.001 and 12.2%, P=0.004, respectively).

Relationship Between Burnout and Workload, Sleep Duration, Work Experience, and Time Spent for Stroke Care and Other Significant Predictors

Analysis of the scores indicated that the number of hours worked per week and time spent in stroke care are positively associated with the severity of burnout (Figure 2B and 2C). In contrast, data analysis also indicates that sleep duration, years of experience, and SF-36 MH are inversely associated with burnout (Figure 2D–2F).

Thus, the study results indicate that a relatively greater workload per week, shorter sleep duration per night, less work experience, and low quality in mental health are all associated with increased prevalence of burnout and burnout severity.

To confirm this trend, we conducted univariate ordinal regression analysis (Table 2). The odds ratio (OR) for burnout was found to increase by ≈2% per additional working hour by the every increase of hours worked (OR=1.02; 95% confidence interval [CI], 1.02–1.03; P<0.001). In contrast, burnout increased as the number of hours slept per night decreased (OR=0.67; 95% CI, 0.61–0.73; P<0.001). Likewise, the OR of burnout was found to be inversely associated with number of years of experience (OR=0.96; 95% CI, 0.96–0.98; P<0.001). The trend of increasing prevalence of burnout with an increasing proportion worked for stroke care is significant (OR=1.05; 95% CI, 1.02–1.08; P=0.001). Low SF-36 MH was also significantly associated with burnout (OR=0.86; 95% CI, 0.85–0.87; P<0.001)

Table 3 shows the predictors that remained in the final prediction model for burnout after performing forward selection. These predictors were number of hours worked per week, number of hours slept per night, number of day-offs per week, number of after-hours calls per week, number of years of experience, and number of patients under care and income (model 1). For neurosurgeons, the number of tissue-type plasminogen activator cases treated per year was also found to increase the risk of burnout by 17% (OR=1.17; 95% CI, 1.03–1.33; P=0.018; model 2). Including SF-36 MH gives a similar result (model 3). The factors associated with burnout are similar between all stroke providers and the subgroup of stroke providers that are neurosurgeons.

Neither combination of interaction terms among best predictor variables was significant. Predicted probabilities of burnout based on sleep duration, workload, and SF-36 MH adjusted for other significant predictors in multivariable ordinal logistic regression are shown in Figure 3.

Institutional Background, Quality of Care, and Burnout

The association of physicians working in teaching hospitals or CSC between the structure aspects of stroke care centers and burnout was investigated. After adjusting by age, working hours, and sleeping hours, those who were in the institutions for thrombolysis therapy certified by Japanese stroke society were slightly increased the risk of burnout. However, those who were in the institutes for hyperacute stroke care certified by government tended to be less burnout (Table 4). Number of beds, existence of stroke care unit, existence of 24-hour MRI/computed tomography, mean values of death rate within 24 hours, mean values of death rate within 30 days, and mean

Table 3. Best Predictors in Multivariable Ordinal Logistic Regression for Burnout

	Model 1			Model 2			Model 3		
Predictors	OR	*P* Value	95% CI	OR	*P* Value	95% CI	OR	*P* Value	95% CI
Hours slept/d	0.80	<0.001	0.73–0.89	0.84	0.019	0.72–0.97	0.84	0.002	0.75–0.94
Day-offs/wk	0.83	0.012	0.71–0.96	0.65	<0.001	0.52–0.82	Not selected	...	...
Hours worked/10 h	1.12	<0.001	1.05–1.18	1.17	<0.001	1.07–1.28	1.08	0.023	1.01–1.15
Experience years/10 y	0.90	0.051	0.81–1.00	0.96	0.021	0.93–0.99	Not selected	...	...
Income/1 million Yen	0.97	0.002	0.94–0.99	0.96	0.021	0.93–0.99	0.98	0.036	0.95–1.00
Patients in charge (n)	1.08	0.004	1.03–1.14	Not selected	...	...	1.08	0.013	1.02–1.15
Extra calls/5 calls	1.26	0.001	1.10–1.45	1.24	0.021	1.03–1.50	Not selected		
No. of operations	Not selected			0.90	0.011	0.83–0.98	Not selected		
No. of t-PA cases	Not selected			1.17	0.018	1.03–1.33	Not selected		
SF-36 MH Score	Not included			Not selected			0.86	<0.001	0.85–0.87

CI indicates confidence interval; OR, odds ratio; SF-36 MH score, Short Foam 36 mental health subscale score; and t-PA, tissue-type plasminogen activator.

Model 1: Significant predictors in Table 2 were considered potential predictors. Forward selection with Akaike information criterion was conducted to select the best prediction model.

Model 2: Analyzed for neurosurgeon only (n=1673). Predictors specific for surgeons, number of operation, number of emergency operation, and number of operation for stroke were included.

Model 3: SF-36 MH score was included in model 1.

values of modified Rankin scale at 30 days were not associated with burnout. We also investigated the process measures, discharge with antithrombotic therapy, discharge with anticoagulation therapy for patients with atrial fibrillation, and discharge with thrombolytic therapy (tissue-type plasminogen activator) and antithrombotic therapy by the end of hospital day 2. They were not significantly associated with burnout.

Discussion

This nation-wide survey of Japanese physicians working in stroke care revealed that this population experiences burnout at a rate considerably higher than that of the general population of Japanese workers. We also demonstrated that longer working hours, short sleep duration, relatively little experience, and low mental quality of life are associated with physician burnout.

The primary hypothesis examined in this study is that the most important risk factor for burnout among physicians working in stroke care is heavy workload, more specifically working an excessive number of hours per week. Whereas the mean number of hours worked per week by the study sample was 66.3 hours, those by the general Japanese population was 45.8 hours in 2010.[17] These findings accord with previous research for general population demonstrating that working an excessive number of hours is a risk factor for burnout[1] and fatigue.[18] The study participants work considerably more hours per week, and they are at greater risk of burnout.

Although this association between high rates of burnout and long working hours accords with a study of US physicians[2] and US surgeons,[2,3] neither of these studies investigated the factors quantitatively. Other previous studies focused on the prevalence of burnout itself or the psychosocial background of the participants and did not discuss this point.[19–21]

The results of the present study also may indicate that sleep duration is associated with burnout. One prospective study reported that insomnia increased emotional exhaustion 3-fold.[22] In 1 prospective observational study, <6-hour sleep caused the risk of clinical burnout.[23] These support our finding, and less sleep is the potential risk factors for burnout. Among physicians, working long hours in addition to taking frequent after-hours calls may decrease sleep duration, cause sleep fragmentation, and increase the risk of burnout. Thus, sleep duration is another important and potential modifiable factor to consider in the prevention of burnout.

Furthermore, interventions aimed at reducing working hours and increasing sleep duration have been found to reduce the prevalence of burnout among physicians. Restriction of working hours in medical residency reduced the mean working hours of 7.5 hours and reduced burnout from 74% to 56%.[24] One intervention that limited the number of hours increases sleep duration and reduces medical errors by >50%.[25] All the findings may indicate that we should start the study whether the reduction of working hours and increase of sleep reduce the burnout among physicians in stroke care.

In addition, the burden of being responsible for emergency admission may have been associated with feelings of being overwhelmed,[26] and physicians working in emergency medicine have been found to experience the highest rate of burnout among all US physicians.[2] This is compatible with our study sample that tissue-type plasminogen activator cases, which are urgent, are associated with burnout for neurosurgeons. From the analysis of backgrounds of institutes, the

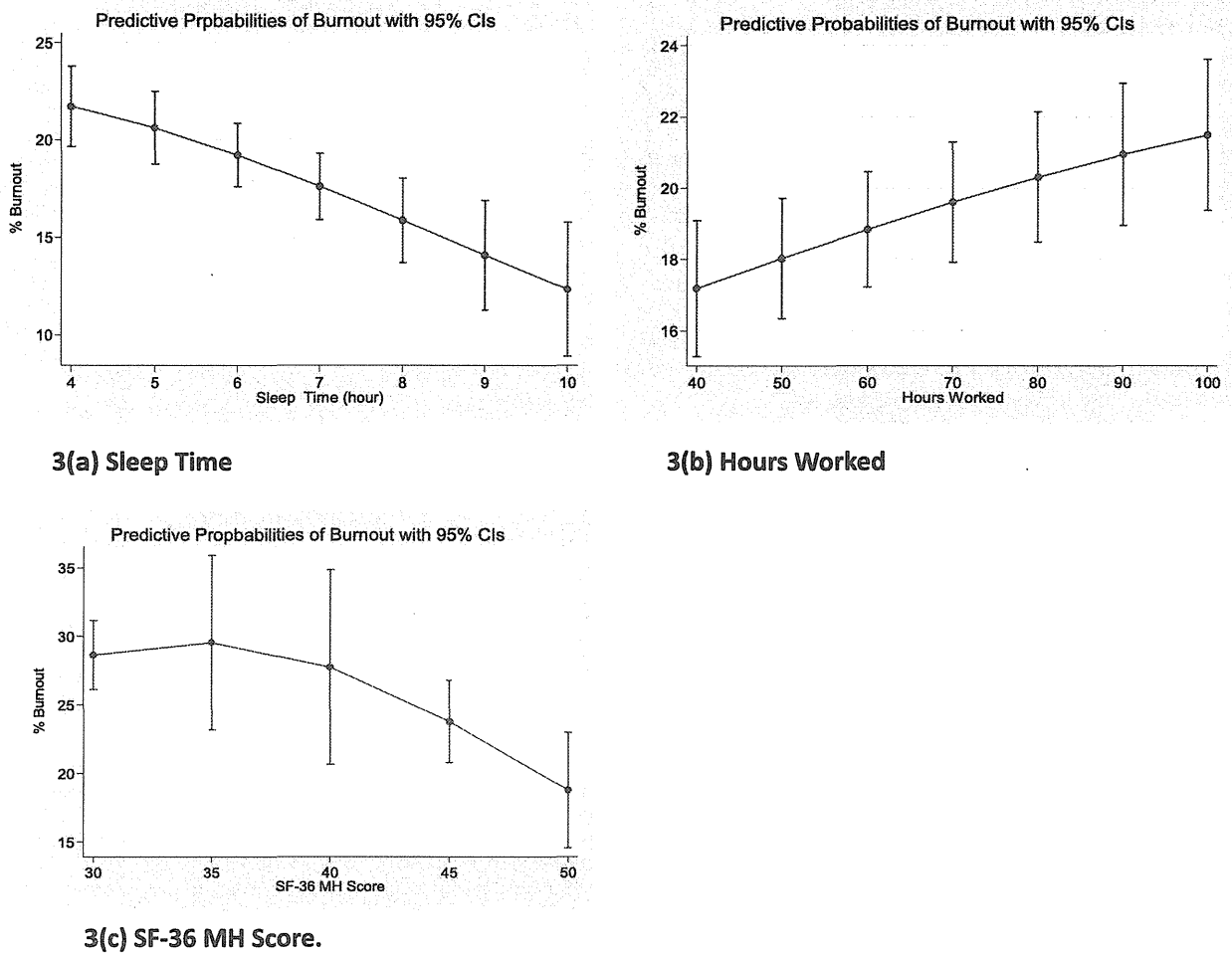


Figure 3. A–C, Relationship between prevalence of burnout and workload, sleep duration, and work experience predicted by multivariable ordinal logistic regression model. Marginal effect was estimated by margin command and plotted by marginsplot command by STATA software adjusted for the predictor in model 3 of Table 3. CI indicates confidence interval; and SF-36 MH score, Short Foam 36 mental health subscale score.

officially credited institutes for thrombolysis therapy are associated with slightly increased the risk of burnout. But, simultaneously, the official credited centers for hyperacute stroke care centers that satisfied the criteria of CSC by Joint Commissions reduced the risk of stroke care ≈21%. This result might suggest that sufficient staffing can reduce burnout, even in intensive care situations.

This study had several strengths that contributed to the reliability and validity of the findings. First, it was the first large study to show an association between physician burnout and workload in Asian countries. Because the rate of burnout among the physicians in this study was found to be similar to that among physicians in western countries,[2,3,27,28] burnout seems to be a common phenomenon among physicians in both the east and the west.

Second, this study examined a sufficiently large sample of physicians with a homogenous training and practice background and varying workloads. In contrast, most previous studies were conducted in a single center using a sample size insufficiently large to identify an association between burnout and workload,[29,30] with even studies using a relatively large sample identifying no association.[27] However, these findings may be attributed to the fact that all of the participants in these studies worked relatively long hours, preventing comparison of the effect of workload among them.

Third, to the best of our knowledge, this study is the first study that demonstrated the close association between burnout and low quality of life assessed by SF-36 MH. Klersy et al[31] reported that lower physical score of SF-36 was associated with emotional exhaustion among Italian healthcare providers of dialysis but no association with SF-36 MH. The population

Table 4. Best Predictors in Multivariable Logistic Regression for Burnout From Institutional Backgrounds

Predictors	Odds Ratio	*P* Value	95% Confidence Interval
Hyperacute stroke care centers	0.79	0.089	0.61–1.04
Certified institutions for thrombolysis therapy	1.08	0.037	1.08–1.16
No. of experience years	0.73	<0.001	0.64–0.84
No. of hours slept/night	0.78	<0.001	0.68–0.88
No. of hours worked/wk	1.11	0.015	1.02–1.21

Forward section with Akaike information criterion was conducted to select the best prediction model.

was considerably different from ours because the burnout rate of Italian health workers was not different from Italian citizens. Also, high burnout rate among Japanese physicians working in stroke care enabled us to reveal the association between burnout and low quality of life.

Finally, this study demonstrated that the risk of burnout is inversely associated with the number of years of experience as had several previous studies.[2,3] This phenomenon is likely because of the fact that promotion to an administrative position after acquiring a certain number of years of experience leads to a decreased clinical workload. It may also reflect a selection bias in those who are more severely burned out quit practice earlier in their carrier. Recent studies suggest that burnout may influence quality of care and lead to early retirement.[32]

In addition, we found some association between burnout and those who in the institutions credited for hyperacute stroke care by Japanese government, which satisfied the components of CSC by the Joint Commissions. This may suggest that the centralization of stroke care in CSC helps to reduce burnout among stroke care. However, the sample size is limited for 59.4% responders and further study is needed for this issues.

Despite these strengths, this study also faced several limitations. First, this study used a cross-sectional design and was thus unable to determine the existence of any direct causal relationships. For example, we demonstrated a cross-sectional association between SF-36 MH scores of the physicians and burnout. Our analysis showed that SF-36 MH is a significant explanatory variable in ordinal logistic regression. However, linear regression analysis showed that the existence of burnout is a significant predictor for low SF-36 MH after adjustment of age, hours slept, and hours worked (data not shown). Thus, we need a prospective cohort study to determine the causality between burnout and potential risk factors in this study. Second, the percentage of female physicians examined in this study was smaller than that of the general population of female physicians in Japan, which was 18.9% of all physicians in 2010.[22] Therefore, the findings may not be generalizable to female physicians. Third, selection bias may have been a significant limitation because physicians who were burned out may have been more or less likely to complete the survey. We cannot comment on how it might influence the generalizability of these observations. We found no significant difference in backgrounds, burnout rate, and workload among early responders compared with late responders using the standard procedure for examining the existence of selection bias, as described by Shanafelt et al.[2] Direct comparison of responders and nonresponders could not be performed as the survey was anonymous.

In conclusion, the results of this study suggest that burnout is highly prevalent among Japanese physicians working in stroke care. The risk factors for burnout seem to be relatively fewer years of work experience, longer working hours per week, and shorter sleep duration per night. Additional prospective research is now needed to assist in the development of interventions to address this pressing problem.

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Disclosures

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare support from the Ministry of Health, Labor, and Welfare, Japan; no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years; and no other relationships or activities that could seem to have influenced the submitted work.

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SUPPLEMENTAL MATERIAL

1.Do you have a part-time job besides a full-time job?

□ No
□ Yes

2.On average, how long do you work in a week?
(Check the appropriate box.)

□ Less than 40 hours
□ 40 to 49 hours
□ 50 to 59 hours
□ 60 to 69 hours
□ 70 to 79 hours
□ 80 to 100 hours
□ More than 100 hours

3.How many times did you work night-duty last month?

Times of night duty _____ times per month

4.How many times were you called out at night? Please fill in the number of calls in each day of the last week.

Seven days ago	Six days ago	Five days ago	Four days ago	Three days ago	Two days ago	Yesterday

5.On average, how many holidays do you have in a week? Please check the most appropriate number.

□ None
□ One

□ Two
□ Three
□ Four or more

6. On average, how many hours of sleep per day do you get at night during weekday? Please fill in the sleep hours and minutes. This time may be different from the time in which you are in bed.

_____ hours _____ minutes per day

7. On average, how many hours of sleep per day do you get at night during weekend? Please fill in the sleep hours and minutes. This time may be different from the time in which you are in bed.

_____ hours _____ minutes per day

8. On average, what percentage in a week do you spend as a non-medical care such as research or education? Please check the most appropriate box.

□ None
□ One to 10%
□ 11 to 20%
□ 21 to 30%
□ 31 to 50%
□ 51% or more

9. On average, what percentage in a week do you spend as a medical care for stroke patients? Please check the most appropriate box.

□ None
□ One to 24%
□ 25 to 49%

□ 50 to 74%
□ 75 to 100%

10. On average, how many patients do you have in charge? Please check the most appropriate box

□ None
□ One to four patients
□ Five to Nine patients
□ 10 to 14 patients
□ 15 to 19 patients
□ 20 or more patients

11.For patients who occurred a stroke within three hours, how many did you treat as a t-PA last year? Please choose the most appropriate number.

□ None
□ One to four patients
□ Five to Nine patients
□ 10 to 14 patients
□ 15 to 19 patients
□ 20 or more patients

Please answer from number 12 to 14 <u>only if</u> you perform surgical treatments including intravascular interventions; otherwise, skip to question 15.

12. How many neurosurgical operations did you perform including intravascular interventions last year? Please choose the most appropriate number.

□ None
□ One to39 patients
□ 40 to 79 patients
□ 80 to 99 patients
□ 100 to 119 patients
□ 120 or more patients

13. How many CDV operations did you perform including intravascular interventions last year? Please choose the most appropriate number.

□ None
□ One to 24 patients
□ 25 to 49 patients
□ 50 to 74 patients
□ 75 to 99 patients
□ 100 or more patients

14.How many emergency operations with CDV did you perform including intravascular interventions last year? Please choose the most appropriate number.

□ None
□ One to 24 patients
□ 25 to 49 patients
□ 50 to 74 patients
□ 75 to 99 patients
□ 100 or more patients

15.How many years are you in practice? Please choose the appropriate number

□ Less than 10 years
□ 10 to 19 years
□ 20 to 29 patients
□ 30 to 39 patients
□ 40 or more years

16.What is your specialty? Please choose the appropriate box

□ Neurosurgery
□ Neurology
□ Emergency medicine
□ Rehabilitation

□ Radiology

17.What are your Board Certifications? Please check all appropriate boxes.

□ Japan Neurosurgical Society Certified Neurosurgeon
□ Societas Neurologica Japonica certified Neurologists
□ Japanese Associations for Acute Medicine certified Acute Care Physician
□ Japan Stroke Society certified Stroke Physician
□ Japanese Society for Neuroendvascular Therapy certified Physician

18.How much is your annual income? Please choose the appropriate number

□ Less than 5,000,000 yen
□ 5,000,000 to 9,990,000 yen
□ 10,000,000 to 14,990,000 yen
□ 15,000,000 to 19,990,000 yen
□ 20,000,000 or more yen

19.What is your relationship status? Please choose the appropriate box

□ Single
□ Divorced
□ Widowed or widower
□ Married

20.If you choose "Married" in question 19, please answer the following question. Does your spouse work outside of home?

□ No
□ Yes

If you choose "Yes" in question 20, please answer the following question.

21.What kind of professional field does your spouse work? Please check the box below.

□ Medical doctor
□ Other health care professionals
□ Other

22.Do you have any children under 22 years old? Please check the box below.

□ No
□ Yes