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Stroke Education Program of Act FAST for Junior High School Students and Their Parents

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Background: We produced a stroke education program using the FAST (facial droop, arm weakness, speech disturbance, time to call an ambulance) mnemonic. *Aims:* The aim of this study is to examine efficacy of our education program for junior high school students and their parents. *Methods:* One hundred ninety students of 3 junior high schools (aged 12-13 years) and their parents were enrolled. Students received a 45-minute lesson of stroke enlightenment using the FAST mnemonic. Enlightenment items, such as a magnet poster, were distributed. Parents were educated indirectly from their child. Surveys of stroke knowledge were examined at baseline, immediately after the lesson, and at 3 months after the lesson. *Results:* For the students, correct answers at 3 months were significantly higher than those at baseline in questions of facial palsy (98% versus 33%), speech disturbance (98% versus 54%), numbness on one side (64% versus 42%), weakness on one side (80% versus 51%), calling an ambulance (88% versus 60%), alcohol drinking (85% versus 65%), smoking (70% versus 43%), dyslipidemia (58% versus 46%), hyperglycemia (59% versus 48%), and obesity (47% versus 23%). At 3 months, the parents answered more correctly questions of facial palsy (93% versus 66%), calling an ambulance (95% versus 88%), and alcohol drinking (65% versus 51%) than at baseline. At 3 months, 96% of students and 78% of parents answered the FAST mnemonic correctly. *Conclusions:* Our stroke education program improved stroke knowledge, especially the FAST message, for junior high school students and their parents. **Key Words:** School-based intervention—stroke enlightenment—stroke knowledge—emergent medical service—prehospital delay.

Introduction

Stroke is a major cause of disability and a major cause of death worldwide. Shortening the time from the onset of stroke symptoms to hospital arrival is important for effective stroke treatment because the early administration of recombinant tissue-type plasminogen activator is beneficial for stroke outcome.[1,2] Both a reduction in the risk of stroke and a decrease in prehospital delay after the onset of stroke are considered to depend on the level of stroke knowledge in the general population.[3] Education program and the target population for education are essential for effective stroke enlightenment. Retained knowledge of stroke awareness results in appropriate

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action of calling emergent medical services (EMS) on stroke onset. Although there are several reports of public education for stroke enlightenment,[4-9] there are only a few studies in children.[10-12] School-based interventions of stroke enlightenment are beneficial for students and a promising means for delivering stroke message to their parents or grandparents.[10-12] The methods used to educate children for stroke enlightenment would be different depending on age, ethnicity, and socioeconomic status of their parents.

Aims

The aim of this study was to examine the efficacy of our stroke education program for junior high school students and their parents.

Methods

Stroke Enlightenment Items

For enlightenment of stroke sign and symptoms, we used "FAST" derived from the Cincinnati Prehospital Stroke Scale, where F is face numbness or weakness, A is arm numbness or weakness, and S is slurred speech or difficulty speaking or understanding.[5,13] We produced a poster measuring 600 × 400 mm, a magnet poster measuring 150 × 105 mm, and a paper file measuring 310 × 220 mm that were printed with the FAST message (Fig 1). School items such as a pen and sticky note with the FAST mnemonic were also produced.

Subjects and Study Design

This study was exempted from approval by the institutional review board based on our domestic guideline because of the use of only an anonymized and untraceable data set. We enrolled 190 students in 6 classes of the first grade of 3 private junior high schools (aged 12-13 years) and their parents. We conducted stroke lessons between October 2010 and March 2011. Students received a 45-minute lesson performed by stroke neurologists. The lesson was composed of a lecture with slide show and a short role-play with students. In the lecture, students were taught stroke risk factors, stroke signs and symptoms, and appropriate urgent responses when they suspected stroke by using FAST mnemonic. Students could understand the FAST mnemonic in English because they had learned the word FAST in English class. In the short role-play, the neurologist acted as an old man just suffering from stroke and students performed in accordance with the FAST mnemonic. At the close of the lesson, we distributed the pen, paper file, magnet posters, sticky notes printed with the FAST message, and papers printed with the lecture slide show to each student. We did not conduct any stroke lessons for the students' parents. Instead, we asked the students to talk about stroke with their parents while showing them the images of the slide show and to place the magnet poster on the kitchen refrigerator. A FAST mnemonic poster was displayed in each classroom for 3 months after the stroke lesson.

For the assessments, multiple-choice and closed-type questionnaires on stroke knowledge (including a total of 7 items for risk factors, 6 items for stroke signs and symptoms, and 1 item for appropriate urgent responses) were filled out by the students at baseline, immediately after the lesson, and at 3 months after the lesson. All data were collected without personal identifiers. For questionnaires at the baseline, questionnaires were distributed to the students within 7 days before the day of the stroke lesson. Students also took the same questionnaires to their parents on the day of the stroke lesson and at 3 months after the lesson. Parents filled out questionnaires before, immediately, and 3 months after talking about stroke with their children. Questionnaires filled out by parents were gathered through their child who took them to their children at school.

Statistical analyses were performed using JMP7.0 (SAS Institute, Inc., Cary, NC). Data are presented as frequencies (%). Data were compared among 3 groups with Fisher exact test: baseline, immediately after the lesson, and 3 months after the lesson. The proportion of selecting "calling EMS" on the identification of stroke signs or symptoms was also assessed with Fisher exact test. A value of P less than .05 was considered to indicate a significant difference.

Result

Assessment for Students

Because a few students were absent from school, the numbers of questionnaires collected immediately and at 3 months after the lesson were 189 (99%) and 187 (98%), respectively. Immediately after the lesson, the frequencies of correct answers for all questions were significantly higher than those at baseline (Table 1). At 3 months after the lesson, the number of students with correct answers of facial palsy (98% versus 33%), speech disturbance (98% versus 54%), numbness on 1 side of body (64% versus 42%), and weakness on 1 side of body (80% versus 51%) were significantly improved. However, severe headache (26% versus 55%) and vision loss (5% versus 17%) were significantly decreased compared with those at baseline. More students answered correctly about calling EMS for stroke (88% versus 60%) and risk factors except hypertension or arrhythmia at 3 months after the lesson compared with those at baseline. The 96% of students who understood the meaning of FAST mnemonic at 3 months after the lesson was similar to that immediately after the lesson.

Assessment for Student's Parents

A total of 183 (96%) questionnaires were filled out by students' parents at baseline, with 155 (82%) immediately,

Figure 1. *FAST message poster for stroke warning signs. FAST represents "F," facial droop; "A," arm weakness; "S, speech disturbance; and "T," time to call an ambulance. The FAST message means that if you recognize one of these symptoms, check the onset time and call an ambulance. These messages are written in Japanese.*

and 175 (92%) at 3 months after the lesson. Parents immediately after the lesson, who chose facial palsy (94% versus 66%), vision loss (46% versus 31%), and speech disturbance (97% versus 91%) as stroke symptoms, 7 correct answers except hypertension as risk factors, and a correct urgent response (97% versus 88%), were significantly higher than those at the baseline (Table 2). At 3 months after the lesson, the number of parents with correct answers of stroke risk factors except alcohol drinking decreased to the same level as those at baseline. However, the correct answer rate of facial palsy (93% versus 66%) and calling EMS (95% versus 88%) persisted as similar to that immediately after the lesson. The 89% of parents who understood correctly the FAST mnemonic immediately after the lesson was similar to that at 3 months after the lesson.

Discussion

Our results showed that our stroke education program by using our homemade items for junior high school students improved their stroke knowledge, especially for the FAST message. Understanding of the FAST message was

Table 1. *The percentages of correct answers to questions about stroke over all 3 surveys for students*

Questions	Baseline (n = 190), %	Immediate after the lesson (n = 189), %	P*	3 months after the lesson (n = 187), %	P*
1. Stroke signs and symptoms					
Headache	55	66	.0359	26	<.0001
Facial palsy	33	98	<.0001	98	<.0001
Vision loss	17	41	<.0001	5	.0003
Speech disturbance	54	97	<.0001	98	<.0001
Numbness on 1 side of the body	42	82	<.0001	64	<.0001
Weakness on 1 side of the body	51	95	<.0001	80	<.0001
2. Adequate action when stroke onset					
Call an ambulance	60	96	<.0001	88	<.0001
3. Stroke risk factors					
Alcohol drinking	65	91	<.0001	85	<.0001
Smoking	43	89	<.0001	70	<.0001
Hypertension	73	97	<.0001	81	.0509
Dyslipidemia	46	85	<.0001	58	.0233
Hyperglycemia	48	81	<.0001	59	.0498
Obesity	23	72	<.0001	47	<.0001
Arrhythmia	39	69	<.0001	43	ns
4. FAST mnemonic					
F = face		100	NA	98	NA
A = arm		99	NA	99	NA
S = speech		100	NA	98	NA
T = time		99	NA	99	NA
All corrected		98	NA	96	NA

Abbreviations: NA, not applicable; ns, nonsignificant.
*Fisher exact test, compared with baseline.

also observed in the students' parents who instructed in stroke enlightenment by their children.

Williams and Noble[10] reported that incorporating cultural elements such as hip-hop music improved retention of stroke knowledge among elementary school children. They also demonstrated the possibility of child-mediated stroke communication from the results of questionnaires for the parents at 1 week after the intervention for the children.[12] Morgenstern et al[11] showed that their stroke enlightenment project, intended for middle school children and their parents/guardians, was beneficial for the children but not for their parents/guardians. In our study, a high rate of correct answers, especially for FAST message, was observed not only immediately but also 3 months after the stroke lesson in students and their parents. The stroke lesson, including the short role-play, would impress the FAST message on students. In addition, our homemade enlightenment items, such as the poster in the classroom, the magnet poster on the refrigerator at home, and stationary (paper file, pen, sticky note with the FAST mnemonic) might fix the FAST message in their minds. On the other hand, stroke symptoms other than FAST, such as severe headache or vision loss, were not recalled by the students after the stroke lesson. Therefore, our items of stroke enlightenment need to be improved for stroke symptoms not involved in the FAST mnemonic and stroke risk factors.

Although our education program was effective in keeping the FAST message in the mind of both students and their parents, it may be difficult to act promptly in calling EMS on the warning signs of stroke in future. Addo et al[14] reported that significant delays in seeking care after stroke still occur after a campaign to promote public awareness of stroke. Fussman et al[15] indicated a lack of association between stroke symptom knowledge and the intent to call EMS in the population-based survey. It would be necessary to repeat education program for fixing stroke knowledge during the junior high school period and to promote motivation for calling EMS by recognition that negative outcomes can be diminished by early awareness as previously indicated.[16] Moreover, not only stroke knowledge but also the presence of bystanders at stroke onset is essential for early arrival at hospital.[17,18] Our school-based stroke education program anticipates that the students would, at some time, play the role of bystander.

There are several limitations to our study. First, our study is not a randomized controlled study. It is difficult to maintain regular lectures of stroke enlightenment of intervention without leakage of the FAST mnemonic to non-intervention classes in the same school during the 3 months of the study period. Although the sample size was not large in this single-arm study, improvement of stroke knowledge was confirmed after our stroke

Table 2. *The percentages of correct answers to questions about stroke over all 3 surveys for parents*

Questions	Baseline (n = 183), %	Immediate after the lesson (n = 155), %	*P**	3 months after the lesson (n = 175), %	*P**
1. Stroke signs and symptoms					
Headache	83	72	.0128	67	.0006
Facial palsy	66	94	<.0001	93	<.0001
Vision loss	31	46	.0069	25	ns
Speech disturbance	91	97	.0122	95	ns
Numbness on 1 side of the body	75	77	ns	78	ns
Weakness on 1 side of the body	81	86	ns	87	ns
2. Adequate action when stroke onset					
Call an ambulance	88	97	.004	95	.0239
3. Stroke risk factors					
Alcohol drinking	51	75	<.0001	65	.0102
Smoking	73	86	.0049	79	ns
Hypertension	92	96	ns	93	ns
Dyslipidemia	80	91	.0057	77	ns
Hyperglycemia	49	67	.0009	49	ns
Obesity	56	68	.0249	54	ns
Arrhythmia	30	52	<.0001	31	ns
4. FAST mnemonic					
F = face		99	NA	90	NA
A = arm		94	NA	86	NA
S = speech		97	NA	93	NA
T = time		96	NA	86	NA
All corrected		89	NA	78	NA

Abbreviations: NA, not applicable; ns, nonsignificant.
*Fisher exact test, compared with baseline.

education program by the high proportion of follow-up examinations performed by either students or their parents. Second, the junior high school for interventions in the present study were conducted at private schools, and the parents of these students would have higher levels of education and upper socioeconomic status that might associate with the higher level of stroke knowledge at baseline as indicated previously.[6] Further examinations using randomized controlled studies that include several public schools with and without educational intervention will be needed. Third, this is a cross-sectional study, and behavioral change of calling EMS at awareness of stroke was not examined. Time monitoring of prehospital delay in the stroke centers within the area of the intervention of stroke education would be expected. Fourth, the assessments of stroke knowledge were examined by multiple-choice and closed-type questionnaires, possibly associated with an overestimate of stroke knowledge compared with open-ended questions. Finally, this study program requires lessons that are given by medical doctors. It would be necessary to require less assistance to spread the stroke enlightenment widely.

In summary, school-based interventions with our homemade items of stroke enlightenment are beneficial for junior high school students and a promising means for delivering the stroke message to their parents. Stroke enlightenment for the youth would promote a healthy life from a younger age, resulting in the primary prevention of cardiovascular disease in the future.

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The Effectiveness of a Stroke Educational Activity Performed by a Schoolteacher for Junior High School Students

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Background: The purpose of this study was to determine whether our stroke education system can help junior high school students acquire stroke knowledge when performed by a schoolteacher. *Methods:* A stroke neurologist gave a stroke lesson to 25 students (S group) and a schoolteacher through our stroke education system. After instruction, the schoolteacher performed the same lesson using the same education system to another 75 students (T group). Questionnaires on stroke knowledge were examined at baseline, immediately after the lesson (IL), and at 3 months after the lesson (3M). We analyzed the results of stroke knowledge assessment by linear mixed effects models adjusted for gender and class difference using the student number. *Results:* We assessed 24 students in the S group and 72 students in the T group. There were no significant differences in the changes of predicted scores of symptoms and risk factors adjusted for gender, class difference, and each student knowledge level until 3M between the 2 groups. Correct answer rates for the meaning of the FAST (facial droop, arm weakness, speech disturbance, time to call 119) at IL were 92% in the S group and 72% in the T group, respectively. At 3M, they were 83% in the S group and 84% in the T group. The correct answer rates of FAST at 3M were not significantly different adjusted for group, gender, class difference, and correct answer rate at IL. *Conclusions:* A schoolteacher can conduct the FAST message lesson to junior high school students with a similar outcome as a stroke neurologist using our stroke education system. **Key Words:** School-based intervention—stroke enlightenment—FAST—online system.

Introduction

Stroke is the leading cause of disability and a main cause of death in Japan. The number of stroke patients and the burden of the elderly population will increase as society ages. With the advantage of acute thrombolytic therapy with intravenous recombinant tissue-type plasminogen activator for stroke outcome,[1,2] shortening the time between symptom onset and hospital arrival is essential for improving stroke outcome. Although the

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European Cooperative Acute Stroke Study III led to the expansion of the therapeutic time window of thrombolysis for acute ischemic stroke,[3] only a small proportion of patients arrive at the hospital within the time window.[4] Improving stroke awareness is an important factor for rapid access to the acute stroke center at symptom onset.

Although several studies have reported that stroke educational campaigns improve public knowledge about stroke in adults,[5-9] only a few studies have examined stroke education programs for children. Stroke enlightenment for youth is a promising strategy for the prevention of cardiovascular disease. Because of compulsory education, implementing stroke lessons in the education programs of elementary or junior high school is a promising means for spreading stroke knowledge in Japan. We developed a stroke education system that is performed by stroke neurologists for junior high school students.[10] As the next step, to extend stroke enlightenment all over the country, we investigated whether this education system was effective when schoolteachers rather than physicians present the stroke lessons to students. The aim of this study was to verify the effectiveness of our education system in junior high schools when performed by a schoolteacher.

Methods

The research was carried out in partnership with the Suita City Board of Education. The Suita City Board of Education approved this study, and this study obtained exempted approval from the institutional review board based on our domestic guideline because of using only an anonymized and unconnectable data set of questionnaire responses.

Subjects

This study was conducted at a public junior high school at Suita City, Osaka Prefecture, Japan, from July 2011 to October 2011. Subjects were 100 students in 4 classes of the third grade (40 girls, 14-15 years old). The subjects were divided into 2 groups: 1 class with 25 students received a 45-minute stroke lesson by a stroke neurologist (S group), and the remaining 3 classes with 75 students in total received a 45-minute lesson by a schoolteacher of health and physical education (T group).

Stroke Education System and Items with FAST Message

Our stroke education system consisted of an online system and the lecture materials were Power Point files including stroke risk factors, signs, symptoms, and the FAST massage (facial droop, arm weakness, speech disturbance, time to call 119).[5] All junior high schools in Suita City have their own computer systems, and each student could use the online systems during the stroke lesson. At first, a stroke neurologist (T.A.) gave the stroke lesson to 25 students (S group) using our online stroke education system (Fig 1, A). A schoolteacher monitored the lecture and received instructions on how to use the stroke education system. Within 2 weeks after the instruction, the schoolteacher performed the lesson using the same system to the other 75 students (T group). Education items of a pen, file, magnet, and sticky note, all recorded with the FAST message (Fig 1, B), were distributed to all the students after the lesson.

Assessments

A questionnaire on stroke knowledge (a total of 12 items for stroke signs and 10 items for risk factors) was examined using the online system in all the students before (baseline [BL]) and immediately after the lesson (IL). At 3 months after the lesson (3M), the same questionnaire was applied. The questionnaire comprised multiple choice questions and close-ended questions, which assessed stroke signs and risk factors. The 12 items for stroke signs included 6 symptoms of stroke ("headache," "vision loss," "facial weakness," "speech disturbance," "numbness on 1 side of the body," and "weakness on 1 side of the body") and 6 incorrect or atypical symptoms ("chest pain," "dyspnea," "weakness on 4 limbs," "abdominal pain," "edema in feet," and "joint pain"). The 10 items for risk factors consisted of 7 stroke risk factors ("alcohol intake every day," "smoking," "hypertension," "dyslipidemia," "hyperglycemia," "obesity," and "arrhythmia") and 3 incorrect or atypical risk factors ("constipation," "urinary frequency," and "stiffness of neck"). Furthermore, the meaning of the FAST message, such as each word of F, A, S, and T, was also examined by a single choice test, at IL and 3M.

Analysis of Data

Statistical analysis was performed using the JMP 8.0 statistical software (SAS Institute Inc., Cary, NC) or Stata software, version 12.0 (StatCorp LP, College Station, TX). We collected individual results of questionnaires on stroke knowledge at each time point until 3M using the unconnectable student number. Results of the questionnaire in each group at BL were compared with those at 3 months and those at IL by the Fisher exact test. For calculating scores, the student got 1 point if he chose a correct answer or did not choose an incorrect answer. Therefore, the scores of questionnaires on stroke signs and risk factors ranged from 0 to 12 and 0 to 10, respectively. In each questionnaire on stroke signs and risk factors, we summed these points of each student in assessing stroke knowledge. Because each student's score was measured repeatedly in a longitudinal manner, linear mixed effects models adjusted for gender and class difference and were used to analyze the association between the score of knowledge for symptoms or risk and lessons

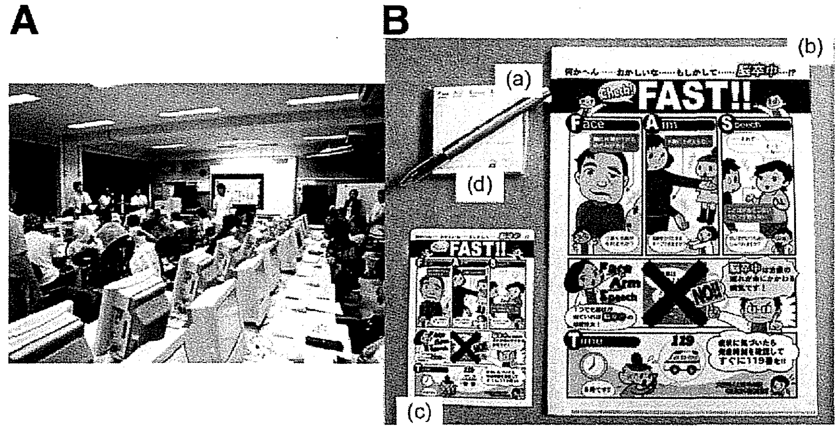

Figure 1. *Stroke lesson and items for junior high school students. (A) Stroke lesson with our online system of stroke enlightenment. (B) School items consisted of pen (a), file (b), magnet (c), sticky note (d) with the FAST message, and stroke pamphlet.*

by each group. It included both a random intercept and time effect for each student. All statistical analyses for assessing stroke knowledge were performed with Stata software using the linear mixed model (MIXED) framework. Statistical significance was established at *P* less than .05.

Results

Four students who did not complete questionnaires at 3M were excluded. Finally, we assessed 24 students (11 girls) in the S group and 72 students (26 girls) in the T group.

Assessment for Stroke Signs and Risk Factors

Changes in the percentage of correct answers to each question about stroke signs and risk factors until 3M are shown in Tables 1 and 2. In the questionnaire on stroke signs at 3M, the correct answers for facial weakness in the S group and facial weakness and speech disturbance in the T group were significantly higher than those at the BL. The proportions of correct answers for alcohol intake, smoking, and obesity in the S group and smoking and hyperglycemia in the T group at IL were significantly higher than those at the BL; however, those differences were disappeared at 3M.

The median scores of the questionnaire on stroke signs and risk factors in the S group at BL, IL, and 3M were 6 (interquartile range 6-8.75), 10.5 (8-11), and 8 (8-9) and 7 (5-7), 9 (8-9), and 8 (6-9), respectively. Those in the T group were 7 (6-9), 10 (8.25-11), and 9 (7-10) and 7 (6-8), 8 (7-9.75), and 7 (6-8), respectively. From the analysis of linear mixed model adjusted for gender, class difference, and each student knowledge level, the scores for symptoms in the T group were 1.38 points higher than those of the S group ($P = .016$). IL, the scores for symptoms were 2.26 points higher, and even after 3 months, the scores were .97 points higher than the scores before lessons ($P < .001$, respectively). The scores for the risks in

Table 1. *Changes of the percentage of correct answers to questions about stroke signs and risk factors in the S group*

	BL (%)	IL (%)	3M (%)	BL vs IL, *P**	BL vs 3M, *P**
1. Stroke signs					
Headache	71	88	42	.287	.080
Vision loss	17	67	13	.001	1.000
Facial weakness	38	71	83	.042	.003
Speech disturbance	67	96	83	.023	.318
Numbness on 1 side of body	46	71	58	.143	.564
Weakness on 1 side of body	54	75	71	.227	.372
2. Risk factors					
Alcohol intake	63	92	83	.036	.193
Smoking	63	92	75	.036	.534
Hypertension	79	83	75	1.000	1.000
Dyslipidemia	71	88	67	.287	1.000
Hyperglycemia	67	71	50	1.000	.380
Obesity	38	79	54	.008	.385
Arrhythmia	67	38	46	.082	.244

Abbreviations: BL, baseline (before the lesson); IL, immediately after the lesson; 3M, 3 months after the lesson.
*Fisher exact test.

Table 2. *Changes of the percentage of correct answers to questions about stroke signs and risk factors in the T group*

	BL (%)	IL (%)	3M (%)	BL vs IL, *P**	BL vs 3M, *P**
1. Stroke signs					
Headache	85	69	50	.046	<.001
Vision loss	40	72	25	<.001	.075
Facial weakness	54	69	90	.086	<.001
Speech disturbance	69	90	92	.003	.001
Numbness on 1 side of body	67	71	64	.719	.861
Weakness on 1 side of body	65	88	74	.003	.366
2. Risk factors					
Alcohol intake	78	89	90	.116	.067
Smoking	74	90	82	.008	.158
Hypertension	83	89	79	.471	.670
Dyslipidemia	69	71	57	1.000	.167
Hyperglycemia	61	78	57	.046	.735
Obesity	51	65	57	.128	.616
Arrhythmia	60	68	49	.386	.181

Abbreviations: BL, baseline (before the lesson); IL, immediately after the lesson; 3M, 3 months after the lesson.
*Fisher exact test.

the T group were also 1.39 points higher compared with those of the S group ($P = .008$). IL, the scores for risks were 1.24 points higher ($P < .001$). However, after 3 months, the increases of the scores were not significant ($P = .246$; Table 3). The predicted score adjusted for gender, class difference, and each student knowledge level are summarized in Figure 2. There were no significant differences in the changes of predicted scores of stroke symptoms or risk factors until 3M between the 2 groups.

Assessment for FAST Message

Correct answer rates for the meaning of the FAST at IL were 92% in the S group and 72% in the T group. At 3 months, the correct answer rates were 83% in the S group and 84% in the T group. Although there was a significant difference among the 4 classes in the correct answer of FAST at IL, no differences were observed between the 2 groups or gender. The correct answer rates of FAST at 3 months were also not significantly different when adjusted for group, gender, class difference, and correct answer rate at IL (Table 4).

Discussion

In this study, we showed that a schoolteacher could conduct a stroke knowledge lesson using our stroke education system that includes stroke symptoms, risk factors, and FAST message to junior high school students with the same outcomes as those obtained by a stroke neurologist. The stroke knowledge of the FAST message and stroke symptoms were preserved until 3 months after the stroke lesson by a schoolteacher and by a stroke neurologist.

Some reports have indicated the significance of school-based interventions of stroke enlightenment. Morgenstern et al[11] reported that a scientific, theory-based, educational intervention could improve intention to call 911 for stroke among middle school children. Williams et al reported that incorporating cultural elements such as hip-hop music improved retention of stroke knowledge for elementary

Table 3. *Linear mixed effect model of symptom and risk scores for the effect of lectures in the S group and time after the lecture adjusted for gender, class difference, and each student*

	Symptom score				Risk score			
	Coefficient	Z	*P* value	95% CI	Coefficient	Z	*P* value	95% CI
Girl	.55	1.97	.048	.00 to 1.09	.59	2.27	.023	.08 to 1.10
Class difference	−.47	−2.49	.013	−.85 to −.10	−.47	−2.64	.008	−.82 to −.12
T group	1.38	2.42	.016	.26 to 2.49	1.39	2.65	.008	.36 to 2.42
Timing of tests								
IL	2.26	8.66	<.001	1.75 to 2.78	1.24	5.43	<.001	.79 to 1.68
3M	.97	3.72	<.001	.46 to 1.48	.26	1.16	.246	−.18 to .71

Abbreviations: IL, immediately after the lesson; 3M, 3 months after the lesson.

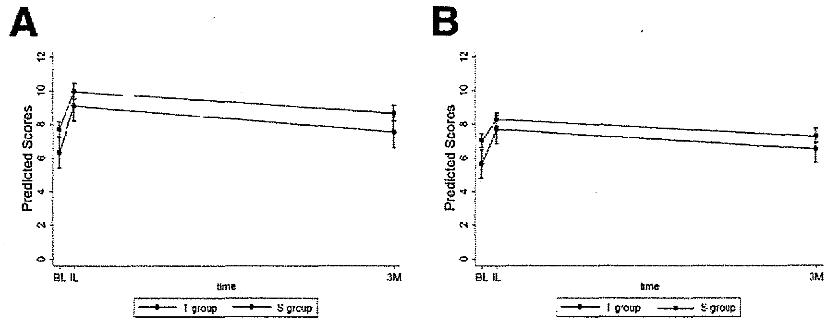

Figure 2. *Predicted score of symptoms (A) or risk factors (B) adjusted for gender, class difference, and each student knowledge level. There were no significant differences in the changes of predicted scores of stroke symptoms and risk factors until 3M between the 2 groups. BL, baseline (before the lesson); IL, immediately after the lesson; 3M, 3 months after the lesson.*

school children[12] and that they would be effective conduits of critical stroke knowledge to their guardians.[13] Previously, we showed that our stroke education program improved stroke knowledge, especially the FAST message, for junior high school students and their parents.[10] These results indicate that school-based interventions of stroke enlightenment are effective for the prevention of not only cardiovascular diseases but also lifestyle-related diseases such as hypertension, diabetes mellitus, and dyslipidemia. In addition, children may educate their parents or grandparents indirectly by communication about their acquisitions of stroke knowledge. From the results of the present study, we propose a new strategy for promoting school-based interventions all over the country that uses schoolteachers in an important role for stroke enlightenment.

In the present study, we analyzed results of questionnaires on stroke knowledge by measuring repeatedly in a longitudinal manner; linear mixed effects models were adjusted for gender and class difference using the student number. These analyses demonstrated the efficacy of our education system performed by either the schoolteacher or stroke neurologist with the handling of the between- and within-student attainment of stroke knowledge. Although the attainment and the BL of stroke knowledge were different between the genders, 2 groups, and among the 4 classes, the correct answer rate of FAST at 3 months is preserved in spite of groups, gender, class differences, and the results at IL. Our stroke enlightenment items, such as the magnet poster on the refrigerator at home and stationaries printed with the FAST mnemonic, may fix the FAST message in their minds. On the other hand, stroke symptoms other than FAST, such as headache and vision loss, were not recalled by the students after the lesson. Our items of stroke enlightenment need to be improved for stroke symptoms not involved in the FAST mnemonic and stroke risk factors.

There are several limitations to our study. First, a relatively small number of subjects in a single junior high school may cause selection bias. However, we showed the effect of our education system by the schoolteacher with the analysis of the between- and within-student difference using linear mixed effects models. Second, we examine the acquisition of stroke knowledge only for students but not their family. We could not evaluate an indirect education effect to their family through students in this study. However, we have showed that our education system was beneficial for their guardians and the student.[10] Third, the assessment of stroke knowledge was examined by multiple-choice and closed-type questions, possibly associated with an overestimate of stroke knowledge compared with open-ended questions. Fourth, our education program in the present study requires access to the Internet for the stroke lesson. However, the online

Table 4. *Multivariate logistic regression of the correct answer of FAST*

	Correct answer of FAST (IL)			
	Odds ratio	*Z*	*P* value	95% CI
T group	7.48	1.54	.125	.57-97.44
Girl	1.19	.3	.766	.38-3.77
Class difference	.21	−3.55	<.001	.09-.50
	Correct answer of FAST (3M)			
T group	1.74	.51	.608	.21-14.41
Girl	.92	−.14	.892	.30-2.87
Class difference	.81	−.46	.645	.34-1.97
Correct answer of FAST at IL	1.22	.27	.791	.28-5.25

Abbreviations: FAST, facial droop, arm weakness, speech disturbance, time to call 119; IL, immediately after the lesson; 3M, 3 months after the lesson.

systems can be accessed by anyone, from anywhere, and at any time, although there may be security issues and server technical issues. The stroke education program with these online systems is a promising means of spreading stroke enlightenment nationwide. Finally, this is a cross-sectional study, and behavioral change of calling emergent medical service at awareness of stroke remained unknown. Significant delays in seeking care after stroke were reported, even after a campaign to promote public awareness of stroke.[14] A lack of association between stroke symptom knowledge and the intent to call EMS was also indicated from a population-based survey.[15] Time monitoring of prehospital delay in the stroke centers within the area of the intervention of stroke education is expected.

In summary, a schoolteacher could play an important role for spreading stroke knowledge all over the country using our stroke education system. Our stroke education system of an online system and school items with the FAST message is a promising means of education for larger student populations. A large study of our education system with multiple urban junior high schools should confirm these findings, and monitoring the changes of prehospital delay in the community is essential.

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Review

Epidemiology and Registry Studies of Stroke in Japan

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Stroke is the most prevalent cardiovascular disease in Japan. This review introduces two epidemiologic studies and four registry studies of stroke in Japan. The Hisayama Study was begun as a population-based prospective cohort study of cerebrovascular and cardiovascular diseases in 1961 in the town of Hisayama. Most of the deceased subjects of the study underwent autopsy examinations from the beginning of the study. Changes in stroke trends in the last 50 years were clarified by comparison of data from different study cohorts registered every 13 to 14 years. The Suita Study was based on a random sampling of Japanese urban residents. Several reports from this study showed the significance of pre-hypertension, as well as hypertension, as a risk factor for stroke by itself and in combination with other underlying characteristics. In addition, the Japan Multicenter Stroke Investigators' Collaboration (J-MUSIC), the Japan Standard Stroke Registry Study, the Fukuoka Stroke Registry, and the Stroke Acute Management with Urgent Risk-factor Assessment and Improvement (SAMURAI) rt-PA Registry are explained as registry studies involving Japanese stroke patients.

Keywords Acute stroke; Asian; Incidence; Japan; Thrombolysis

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Introduction

Stroke is the most prevalent cardiovascular disease and the most prevalent neurological disease in Asia.[1] Many countries in East Asia and Southeast Asia have higher mortality rates from stroke than from ischemic heart disease, the opposite of Western countries.[1] The prevalence of intracerebral hemorrhage (ICH) and intracranial arterial sclerosis is another unique feature of Asian patients.[2,3] Among Asian countries, Japan was the first to become an aging society; the others, in particular Korea, have been rapidly approaching one. Thus, the epidemiologic characteristics of stroke in Japan seem to be good examples for other countries.

In this review, epidemiological studies and patients' registry studies of stroke in Japan are briefly introduced.

The Hisayama Study

The Hisayama Study was begun as a population-based prospective cohort study of cerebrovascular and cardiovascular diseases in 1961 in the town of Hisayama, a suburban community adjacent to the Fukuoka metropolitan area, Kyushu, in western Japan. Four study cohorts were established from Hisayama residents ≥ 40 years of age in 1961, 1974, 1988, and 2002 after screening examinations. One of the strengths of this study is that most of the deceased subjectsof the study underwent autopsy examinations from the beginning of the study (80% between 1962 and 1994),[4] and thus, the morphological features of the brains examined by autopsy or brain imaging are available for most of the stroke cases in each cohort. The study was initiated to respond to the doubts of Western researchers in the pre-

CT era that the very high mortality from ICH in Japan might be due to overdiagnosis of ICH. The autopsy results in the consecutive residents proved that the prevalence of ICH was not so high as was believed by Japanese physicians but also showed that ICH was still more common than ischemic stroke as a cause of death in Japan.[5]

Of the many studies on stroke and other neurological diseases including dementia, those on stroke incidence and mortality are briefly introduced here. After 12-year follow-up for each of the first three study cohorts, the age-adjusted incidences of total stroke were 1,210 per 100,000 person-years for men and 598 for women in the first cohort (1961); they declined steeply in both sexes from the first to the second cohort (1974) and then declined relatively moderately in both sexes from the second to the third cohort (1988, Figure 1).[6] Changes in the incidence among cohorts differed greatly between ischemic stroke and ICH. The incidence of ischemic stroke declined by 37% for men from the first to the second cohort, while the incidence of ICH declined by 61% for men. In contrast, the age-adjusted incidences of coronary heart disease were 340 per 100,000 person-years for men and 113 per 100,000 person-years for women in the first cohort, and they increased for both sexes in the newer cohorts, although they were much smaller than the stroke incidences in all of the cohorts. The different tendencies in the changes in incidence between stroke and coronary heart disease seem to be partly due to changes in prevalence of cardiovascular risk factors among the three cohorts: severe hypertension and current smoking became significantly less frequent, while glucose intolerance, dyslipidemia, and obesity became more frequent. Stroke mortality declined continuously as a result of changes in stroke incidence and significant improvements in acute stroke management; the age-adjusted stroke mortalities among the three cohorts were 634 (the first cohort: 1961), 232 (the second cohort: 1974), and 138 (the third cohort: 1988) per 100,000 person-years, respectively, for men and 286, 162, and 102 per 100,000 person-years, respectively, for women.

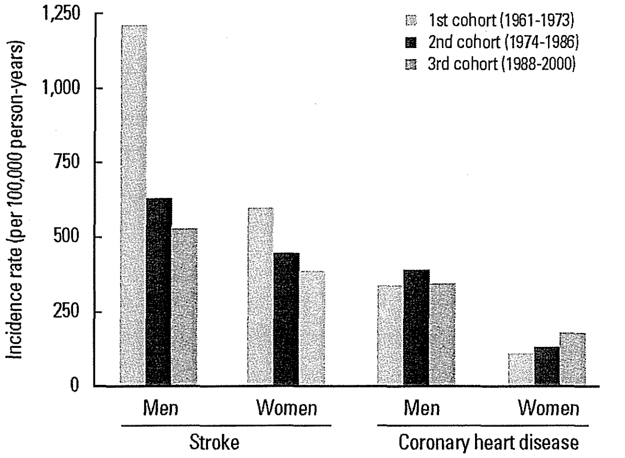

Figure 1. Age-specific incidences of stroke and coronary heart disease among the 3 cohorts of the Hisayama Study, with 12-year follow-up in each cohort.[6]

Among the ischemic stroke subtypes, the age-adjusted incidence of lacunar infarction declined significantly from the first to the third cohort for both sexes (5.68 per 100,000 person-years in the first cohort and 1.59 per 100,000 person-years in the third cohort for men during the 13-year follow-up), whereas the incidences of atherothrombotic and cardioembolic infarctions did not change during this period.[7] As a result, the proportion of ischemic stroke subtypes differed greatly among the 3 cohorts; two-thirds of the male patients had lacunar infarction in the first cohort, compared to two-fifths in the third cohort. The high incidence in the first cohort and recent decline of lacunar infarction were similar to those for ICH, suggesting that intracranial small artery disease has been prevalent in the Japanese population and that the effect of recent developments in preventive therapy, especially antihypertensive therapy, are protective from development of the small artery disease.

Of the 410 patients in the first cohort who developed first ever stroke during 32-year follow-up, 108 (26%) experienced recurrent stroke within 10 years after the index stroke.[8] The cumulative recurrence rates at 1, 5, and 10 years were: 10.0%, 34.1%, and 49.7% after ischemic stroke; 25.6%, 34.9%, and 55.6% after ICH; and 32.5%, 55.0%, and 70.0% after subarachnoid hemorrhage (SAH), respectively.

Of the 333 patients in the first cohort who developed first-ever stroke during 26-year follow-up, 268 (80.5%) died within 10 years after the index stroke, of whom 239 (89.2%) underwent autopsy examinations.[9] The risk of death was greatest in the first year (men 40.3%; women 43.7%). The 30-day case fatality rate was substantially greater in patients with ICH (63.3%) or SAH (58.6%) than in patients with ischemic stroke (9.0%). The risk of dying after the index stroke was twelve times higher during the first year and two times higher during the overall 26-year period as compared to the risk for stroke-free controls. The most common cause of death was the index stroke in the first year, and the impact of recurrent stroke increased gradually thereafter.

The Hisayama Study is one ofthe first sophisticated epidemiological study and one of the most successful epidemiological study of cerebrovascular and cardiovascular diseases in the world. Several unique characteristics of Asian stroke patients were ascertained by this study. The Hisayama Study is still developing by expanding the target diseases into common nonvascular diseases and by adding genomic information for the analysis.

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The Suita Study

Following the Hisayama Study, several epidemiological projects on cerebrovascular and cardiovascular diseases were started in Japan. Most of the study cohorts involved rural or suburban residents, since they are likely to continue to live in the area. The Suita Study was unique in that urban residents were registered.

Suita city, which contains the National Cerebral and Cardiovascular Center where the author works, is located adjacent to Osaka city, which is the second largest metropolitan area in Japan. The Suita Study was based on a random sampling of 12,200 Japanese urban residents. At baseline, participants between the ages of 30 and 79 years were randomly selected from the municipality's population registry and stratified into groups by sex and age in 10-year increments in 1989. Of these, 6,485 people underwent regular health checkups between 1989 and 1994. During an average 11.7-year (64,391 person-years) follow-up period, 213 strokes, consisting of 141 ischemic stroke, 32 ICH, 22 SAH, and 18unclassified strokes, and 133 myocardial infarctions were documented.[10,11] Thus, the incidence of stroke did not differ much as compared to that of myocardial infarction in contrast to the high stroke incidence in the Hisayama Study (especially in its first cohort; the age-adjusted incidence of total stroke for menbeing 1,210 per 100,000 person-years and that of coronary heart disease being 340 per 100,000 person-years), although adjustments for age and other conditions are needed for accurate comparison between the studies. These findings suggest that the data from the Suita Study were influenced by the Western lifestyle, particularly diet.

Among the many publications from the Suita Study, those on the association between blood pressure (BP) levels and stroke incidence are briefly introduced here. The association between high-normal BP and cerebrovascular and cardiovascular disease had not been well studied in the Asian population. The percent ages of the participants with optimal, normal, and high-normal BP and hypertension Stage 1 and Stage ≥2, according to the ESH-ESC 2007 criteria, were 31%, 20%, 18%, 20%, and 11% for men and 42%, 17%, 16%, 16%, and 9% for women, respectively.[9] Compared with the optimal BP group, the multivariate hazard ratios (HRs) (95% confidence intervals [CIs]) of stroke for normal and high-normal BP and hypertension Stage 1 and Stage ≥2 were 2.12 (1.04 to 4.30), 2.43 (1.21 to 4.86), 2.62 (1.35 to 5.09), and 4.38 (2.24 to 8.56) in men and 1.05 (0.49 to 2.24), 1.29 (0.63 to 2.67), 1.21 (0.61 to 2.45), and 2.20 (1.07 to 4.50) in women, respectively; the risk of myocardial infarction for each BP category was similar to that of stroke. Population-attributable fractions of high-normal BP and hypertension for combined stroke and myocardial infarction were 12.2% and 35.3% in men and 7.1% and 23.4% in women, respectively (Figure 2). These findings indicate the significance of pre-hypertension as a vascular risk factor and the necessity for pre-hypertensive patients to attempt to control BP through lifestyle modifications.

The combined impacts of BP categories and other risk factors were also thoroughly investigated in the Suita Study. A study on glucose abnormalities and that on chronic kidney disease (CKD) are summarized.[11,12] The percentages of subjects with normoglycemia, impaired fasting glucose, and diabetes mellitus, defined according to the 2003 American Diabetes Association recommendations, were 59%, 35%, and 6% for men and 75%, 21%, and 4% for women, respectively.[12] Compared with normoglycemic subjects, the multivariate HRs (95% CIs) for stroke were 1.11 (0.81-1.52) in individuals with impaired fasting glucose and 2.08 (1.29-3.35) in individuals with diabetes mellitus. Compared with normoglycemic and optimal BP subjects, increased risks of combined stroke and coronary heart disease were observed in the normoglycemic subjects with high-normal BP or hypertension, in impaired fasting glucose subjects with normal or higher BP, and in diabetic subjects regardless of BP category (P-value for interaction = 0.046). The percentages of CKD subjects, defined as an estimated glomerular filtration rate

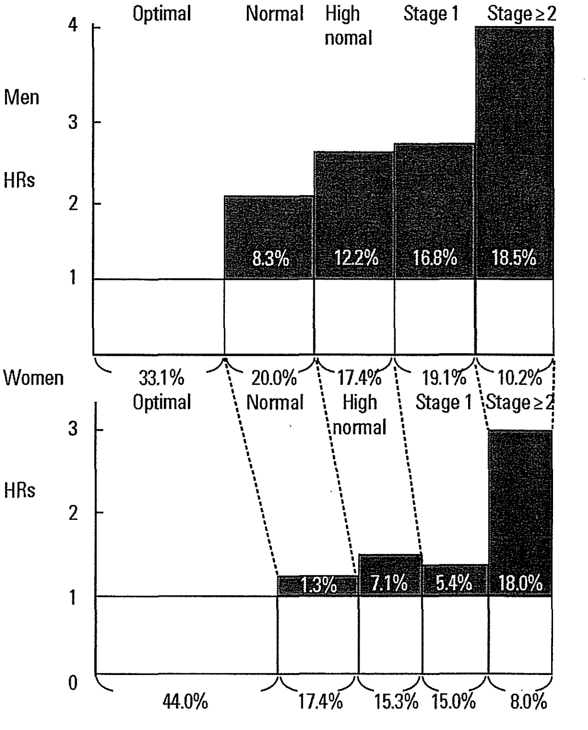

Figure 2. The HRs and positive fractions attributable to exposure to each blood pressure category at baseline for cardiovascular disease (including stroke): the Suita Study. The gray area displays the excessive incidence of CVD due to normal and high-normal blood pressures and hypertension stages 1 and ≥2 (From reference 10 with permission).

(GFR) < 60 mL/min/1.73 m^2, using the Modification of Diet in Renal Disease equation modified by the Japanese coefficient (0.881), were 8.9% for men and 11.3% for women.[10] Compared with the GFR ≥90 mL/min/1.73 m^2 group, the HRs (95% CIs) for stroke were 1.9 (1.3 to 3.0) in the GFR 50 to 59 mL/min/1.73 m^2 group and 2.2 (1.2 to 4.1) in the GFR < 50 mL/min/1.73 m^2 group. Compared with the optimal BP subjects without CKD, the normal BP, high-normal BP, and hypertensive subjects without CKD showed increased risks of stroke. However, the impact of each BP category on stroke (P for interaction: 0.03 in men, 0.90 in women) was more evident in men with CKD. These results show that pre-hypertension can be a stronger vascular risk factor when combined with other traditional and newer risk factors than when it is the sole risk factor.

As is known, extracranial carotid atherosclerotic lesions are less frequent in the Asian population than in the Western population. The prevalence of asymptomatic extracranial carotid artery lesions and its relationship to cardiovascular risk factors were determined using ultrasound in the Suita residents.[13] Significant sex differences were shown in the prevalence of atherosclerotic lesions in the extracranial carotid artery; 4.4% of all the subjects, 7.9% of the men, and 1.3% of the women aged 50 to 79 years had atherosclerosis accompanied by area stenosis > 50%, and these values increased to 6.5%, 11.1%, and 2.1% for the subjects aged 60 to 79 years, respectively (Figure 3). In addition, accumulation of established major coronary risk factors (i.e., hypertension, smoking, and hypercholesterolemia) affected carotid atherogenesis in both sexes.[14]

Registry studies on stroke

In this chapter, major registry studies on ischemic stroke in Japan are introduced (Table 1).

The Japan Multicenter Stroke Investigators' Collaboration (J-MUSIC) was a nationwide, multicenter, prospective, hospital-based registration study from May 1999 through April 2000, when intravenous recombinant tissue plasminogen activator (rt-PA) was not yet approved for clinical use. A total of 156 hospitals participated in the study, and 16,922 patients (70.6± 11.5 years old) with acute ischemic stroke (94%) and transient ischemic attack (TIA, 6%) who were hospitalized within 7 days of onset were registered. As was common in the Asian population, lacunar stroke was the leading subtype (38.8%), followed by atherothrombotic (33.3%) and cardioembolic stroke (21.8%).

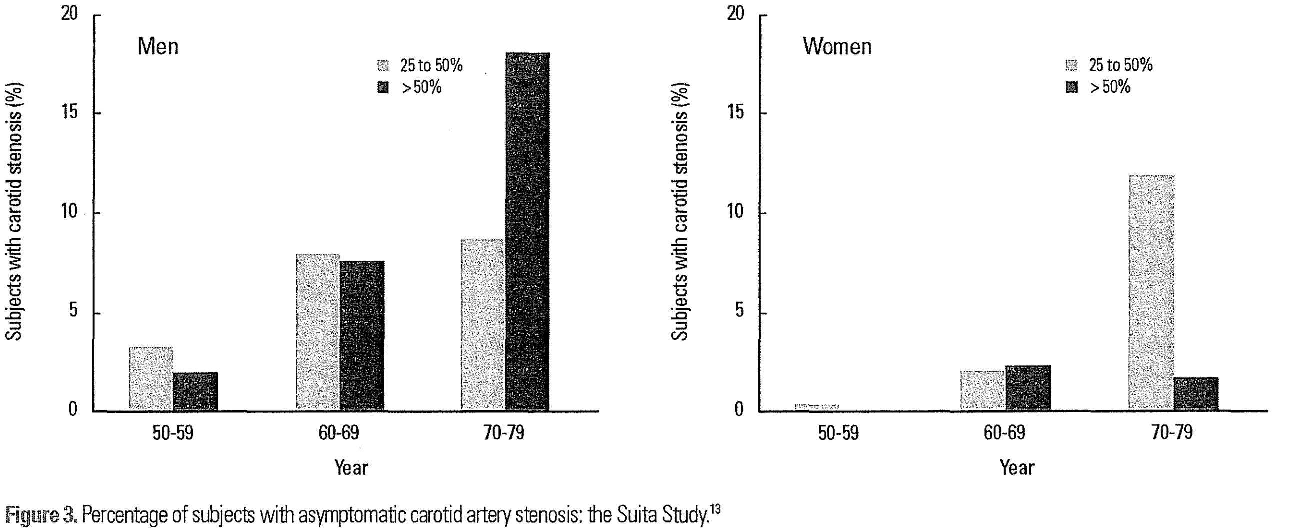

Figure 3. Percentage of subjects with asymptomatic carotid artery stenosis: the Suita Study.[13]

Table 1. Registry studies on Japanese stroke patients

Study	Years	Patients	Patient number	Institutes
Japan Multicenter Stroke Investigators' Collaboration (J-MUSIC)	1999-2000	Ischemic stroke and transient ischemic attack (TIA), ≤7 days	16,922	156 hospitals over Japan
Japan Standard Stroke Registry Study (JSSRS)	2000-ongoing	Stroke and TIA, ≤7 days	Ongoing (47,782 by Nov 2007)	162 hospitals over Japan
Fukuoka Stroke Registry (FSR)	Retrospective: 1999-2007 Prospective: 2007-ongoing	Stroke, ≤7 days	Retrospective: 5,547 Prospective: Ongoing (4,315 by Feb 2011)	7 hospitals in the Fukuokametropolitan area
Stroke Acute Management with Urgent Risk-factor Assessment and Improvement (SAMURAI) rt-PA Registry	2005-2008	Ischemic stroke receiving intravenous rt-PA	600	10 hospitals over Japan

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The median National Institutes of Health stroke scale (NIHSS) score on admission was 5 (interquartile range 2 to 11), and 60.8% of the patients had a modified Rankin Scale (mRS)score of 0-2 at discharge, while 6.9% died during acute hospitalization.[15] In the follow-up study of survivors, the 1-year cumulative mortality was 6.8%, which was relatively low compared to that from Western countries.[16] The cause of death included cerebrovascular disease in 24.1%, pneumonia in 22.6%, heart disease in 18.1%, and cancer in 11.0%.

The Japan Standard Stroke Registry Study (JSSRS) is an ongoing multicenter stroke registration study based on a computerized database from 162 Japanese institutes. From January 2000 through November 2007, a total of 47,782 patients with acute stroke and TIA who were hospitalized within 7 days after onset was registered. Many subanalyses of the registry data have been reported in Japanese books published every two to four years. As the major findings, 75.4% of stroke patients had ischemic stroke, 17.8% had ICH, and the remaining 6.8% had SAH. As subtypes of ischemic stroke, 33.9% had atherothrombotic, 31.9% had lacunar, and 27.0% had cardioembolic stroke. It is interesting that the leading stroke subtype changed from lacunar stroke in J-MUSIC (1999-2000) to atherothrombotic stroke in JSSRS (2000-2007), although the participating hospitals and designs of the two studies were not identical. Effects of sex and age on stroke subtypes, underlying risk factors, initial conditions at onset, and outcomes of ischemic stroke patients were reported in English.[17] Briefly, women were older than men at stroke onset (75.0 ± 11.7 years versus 69.3 ± 11.4 years), and women more frequently had cardioembolic events (odds ratio [OR] 1.090, 95% CI 1.036 to 1.146) after age-adjustment. Onset-to-arrival time was longer ($\beta = 0.0554$, $P = 0.026$), the initial NIHSS score was higher ($\beta = 0.1565$, $P < 0.001$), and duration of hospitalization was longer ($\beta = 0.0355$, $P = 0.010$) in women than in men after multivariate adjustment. At hospital discharge, women less commonly had an mRS score of 0-1 (OR 0.802, 95% CI 0.741 to 0.868) and more commonly had an mRS score of 4-6 (OR 1.410, 95% CI 1.293 to 1.537) than men. Thus, women developed more severe strokes than men in Japan.

The Fukuoka Stroke Registry (FSR) is an ongoing, multicenter, hospital-based registry in which acute stroke patients were enrolled from seven stroke centers in the Fukuoka metropolitan area. The FSR has the strengths that the database extensively collected underlying patients' information, image data principally using MRI/MRA, long-term follow-up of vital and functional conditions for years, and serological and genome genetic analyses for most participants. The associations of several risk factors, including pre-stroke glycemic control[18] and admission proteinuria[19] with clinical outcomes of ischemic stroke patients were published in the last couple of years. As a unique risk factor of ischemic stroke in Japanese, and probably in Korean people, a windblown sand dust originating from mineral soil in the deserts of China and Mongolia was significantly associated with the incidence of atherothrombotic brain infarction after adjusting for expected confounders, including meteorologic variables and other air pollutants in this cohort.[20]

Finally, let us consider the Stroke Acute Management with Urgent Risk-factor Assessment and Improvement (SAMURAI) rt-PA Registry.[21] This registry included 600 consecutive patients (377 men, 72 ± 12 years old) with ischemic stroke and TIA who received intravenous rt-PA therapy in ten Japanese stroke centers that were balanced regionally between October 2005 (when intravenous alteplase therapy was approved in Japan) and July 2008. Symptomatic ICH within 36 hours with $\geq$ 1-point increase from the baseline NIHSS score developed in 3.8% of patients (95% CI 2.6 to 5.7%). At 3 months, 33.2% (95% CI 29.5 to 37.0%) of patients had an mRS score of 0-1, and the mortality was 7.2% (95% CI 5.4 to 9.5%). Analysis of 399 patients with a premorbid mRS score ≤ 1 who met the approved European indications(≤ 80 years old, an initial NIHSS score ≤ 24, etc.) showed that 40.6% (95% CI 35.9 to 45.5%) had a 3-month mRS score of 0-1. These percentages were similar to those in Western postmarketing surveys using 0.9 mg/kg alteplase. Several published subanalyses clarified the associations of risk factors and initial stroke features with thrombolysis outcomes.

The publications that were discussed in this review dealt with only a small part of each study, and the studies that were introduced represent only a small part of Japanese epidemiologic and registry studies. The author hopes that the readers of this journal will find the similarities (or differences) in stroke epidemiology between Japanese people and those in other countries of great interest.

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