Development of an Educational Program for Staffs of Emergency Medical Service to Improve Their Awareness of Stroke within 3 Hours of Symptom Onset: A Pilot Study

Han-Chieh Hsieh[1], Cheng-Yang Hsieh[2], Chih-Hao Lin[3], Pi-Shan Sung[4,5], Chung-Yi Li[6], Chih-Hsien Chi[3], Chih-Hung Chen[4,5]

Abstract-

Purpose: Timely identification and transport are crucial for the pre-hospital management of stroke by emergency medical service (EMS) providers. In this preliminary study, our aim was to develop an educational program which can improve 1) stroke knowledge and 2) triage accuracy of identifying acute stroke within 3 hours of symptom onset by dedicated EMS providers in Tainan city.

Methods: A total of 33 providers received a written test before, immediately after, and 3 months after completing the educational program, which was about stroke knowledge, diagnosis, and management. The test (total score, 39) contained three sections: two on stroke knowledge (consisting of true-false and choice questions) and one on clinical scenarios (situational descriptions and videos).

Results: The mean total score improved significantly immediately after the program (34.2 ± 2.2 vs. 37.3 ± 1.7, $p<0.001$). An increase in mean score was also noted for all three sections. The increase in total score lasted 3 months (36.4 ± 1.9 vs. 34.1 ± 2.2, $p=0.002$). The linear regression model showed greater improvement on scores correlated with lower pretest total score only, not correlated with age, gender, work year and the learning or working experience.

Conclusion: The educational program increased knowledge about stroke and improved the accuracy of triage by dedicated EMS providers. Further investigation is needed to determine the effectiveness of similar educational programs for non-dedicated EMS responders.

Key Words: acute stroke, education, emergency medical service, stroke knowledge

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From the [1]Department of Neurology, Tainan Hospital, Department of Health, Tainan, Taiwan; [2]Department of Neurology, Sin-Lau Hospital, Tainan, Taiwan; [3]Department of Emergency Medicine, College of Medicine, National Cheng Kung University, Tainan, Taiwan; [4]Stroke Center, National Cheng Kung University Hospital, Tainan, Taiwan; [5]Department of Neurology, National Cheng Kung University, Tainan, Taiwan; [6]Institute of Public Health, College of Medicine, National Cheng Kung University, Tainan, Taiwan (Cheng-Yang Hsieh has equal contribution with Han-Chieh Hsieh in this study)

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Correspondence to: Chih-Hung Chen, MD. Department of Neurology, College of Medicine, National Cheng Kung University, Tainan, Taiwan. No. 1, University Road, Tainan 701, Taiwan.
E-mail: CHC: lchih@mail.ncku.edu.tw

INTRODUCTION

Stroke is one of the leading causes of death and disability, and acute ischemic stroke (AIS) is the most common subtype of stroke in Taiwan[1]. Recombinant tissue plasminogen activator (tPA) is the only approved treatment worldwide for AIS within 3 hours of onset. However, due to the narrow 3-hour time window, tPA is often underutilized and the most common reason for exclusion is prehospital delay[2]. Timely identification and transport are crucial for effective prehospital stroke management[3]. Coordination between hospitals and emergency medical service (EMS) responders has been shown to increase the rate of thrombolytic utilization[4-6]. Paramedic training plays an important role in the success of prehospital stroke management increasing the accuracy of identification of candidates and use of prenotification to the stroke center[4,5]. However, Gladstone et al. reported that increasing the number of suspected stroke patients who actually had no stroke would overwork the hospital staff and required the transfer of patients due to insufficient hospital bed capacity[6]. Therefore, paramedic training for the triage accuracy of stroke patients, especially those whose onset was within 3 hours, should be commenced before the implementation of a stroke protocol between emergency duty hospitals and EMS.

We initiated a training program for EMS providers in Tainan city to facilitate triage of acute stroke patients potentially eligible for tPA treatment and their transfer to hospitals with stroke centers capable of administering thrombolytic therapy. In this preliminary study, our aim was to develop an educational program which can improve 1) stroke knowledge and 2) triage accuracy of identifying acute stroke within 3 hours of symptom onset by dedicated EMS providers in Tainan city.

METHODS

Dedicated EMS Teams in Tainan City

Tainan city is located in the southwest part of Taiwan. The combined population of Tainan city and Tainan county (which were consolidated in 2010) of 1.8 million people live in an area of 2.2 thousand square kilometers. There were 60 EMS teams and 66,136 patient transports in Tainan city in 2010. Six dedicated EMS teams, i.e., Nan-Men, Her-Wei, Ho-Jia, Yuon-Hwa, An-Nan and Yong-Kang, transported 21% of all patients using EMS in Tainan city in 2010. The difference between dedicated and non-dedicated EMS teams is that the former is focused exclusively on emergency medical transport, and is not involved in disaster rescue or fire fighting. Each dedicated EMS team has 8 members and is separated into 2 divisions. In each division, one EMT-P (emergency medical technician-paramedic) leads three EMT-IIs.

Development of an Educational Program

To construct a regional education protocol, we organized an inter-hospital network and at least one neurologist in the six different hospitals in Tainan City participated in this network. Our educational program was developed for the EMS teams in Tainan. It was accomplished in annual dedicated EMS training course of Tainan City Government Fire Bureau in August in 2011. This 1-hour course provided introductory information about stroke, including stroke epidemiology, symptoms, diagnosis, management, and determination of onset time. We also conducted the class for paramedic diagnosis for acute stroke within three hours of symptom onset.

Test Construction

A written test was designed to assess knowledge of stroke, stroke management, and the paramedic diagnosis of stroke in different situations, which was the most important subject in our study. In the first two parts of the test, 10 true-and-false questions and 7 choice questions (including 3 multiple-choice and 4 single-choice questions) were used to assess knowledge of stroke. All these questions were edited by the stroke experts and experienced neurologists from the hospitals in Tainan City. In the third part of the test, course participants were asked to determine whether the situation was consistent with stroke onset within 3 hours. We also prepared 5 video scenarios, acted by two trained simulated patients and two EMT-Ps. There were another 5 written scenarios. The videos and written descriptions were shown to

Table 1. English version of the test

Part A. True-and-false questions:

1. Stroke usually occurs suddenly.
2. Stroke can occur at any age.
3. There are two types of stroke, hemorrhagic and ischemic.
4. Traumatic intracranial hemorrhage is also regarded as stroke.
5. In Taiwan, ischemic stroke is accounted for most of the strokes.
6. All stroke patients can be treated with thrombolytic agent (tissue plasminogen activator, t-PA).
7. The "golden 3-hour" represents that t-PA should be given for ischemic stroke patients only within three hours of symptom onset, according to the approved indications from Department of Health.
8. T-PA can improve the outcome of acute ischemic stroke patients.
9. Neither adverse effect nor risk is noted with t-PA use.
10. It is most effective if we puncture the fingers of stroke patients when they are comatose.

Part B. Multiple-choice and single-choice questions:

1. What are the possible symptoms of stroke?
   ① Sudden onset of slurred speech
   ② Sudden severe, explosive headache
   ③ Numbness over unilateral extremities and face
   ④ Continuous tearing
   ⑤ Unilateral paralysis (hemiparesis)
2. What are the common risk factors of stroke?
   ① Hypertension
   ② Diabetes mellitus (DM)
   ③ Cigarette use (smoking)
   ④ Hyperlipidemia
   ⑤ Liver cirrhosis
3. How to prevent stroke?
   ① Treat hypertension
   ② Cigarette cessation
   ③ Take unapproved advertisement medicine
   ④ Exercise
   ⑤ Treat DM
4. What is the most common recommended medication to prevent ischemic stroke?
   ① Ginkgo
   ② "Yo-Lu-An" (an advertisement medicine for common cold)
   ③ Vitamin B
   ④ Aspirin
   ⑤ Acetaminophen (panadol)
5. What is the most proper management when we encounter an acute stroke patient?
   ① Rest the patient at home
   ② Puncture the patient's fingers
   ③ Pinch the patient's hand with effort
   ④ Bring the patient to emergency room as soon as possible
   ⑤ Bring the patient to local medical clinic initially and wait for any suggestion of transfer to hospital

Table 1. English version of the test (continue)

6. Stroke is the leading cause of death in Taiwan in recent years?
   ① First
   ② Second
   ③ Third
   ④ Fourth
   ⑤ Fifth
7. A patient suddenly developed right-sided numbness and paralysis and can't talk; what is the most possible diagnosis?
   ① Seizure
   ② Brain tumor
   ③ Stroke
   ④ Parkinson's disease

Part C. Video section: Does the patient have stroke onset within three hours?

Video 1: A 76-year-old lady, with hypertension history, was quite normal before sleep last midnight (12am). She was noticed with right-sided paralysis when she tried to get up at 7am this morning. Her husband called 119 at 7:10am and the EMT arrived 10 minutes later.

Video 2: A 76-year-old man, with hypertension history, could walk to toilet as usual at 5am today. However, he was noticed with right-sided paralysis when he tried to get up at 7am. His family called 119 at 7:10am and the EMT arrived 10 minutes later.

Video 3: A 76-year-old lady, with hypertension history, got up and walked to toilet as usual at 7am today. After she did the tooth-brushing and washing her face, she walked out the restroom at 7:10am. However, she had sudden left-sided paralysis and then fell down. Her husband called 119 at 7:20am and the EMT arrived 10 minutes later.

Video 4: A 73-year-old man, who took antidiabetic agents every morning, had vomiting and diarrhea last night. He had general malaise but still took the medication as usual at 8am this morning. One hour later, his daughter noticed he was very drowsy and could not move his left side extremities. She checked blood sugar level for her father and it was only 40mg/dl. She called 119 immediately and the EMT arrived 10 minutes later.

Video 5: A 78-year-old man, who had stroke history, also had generalized convulsion for three times after stroke. He could have his lunch as usual when his daughter went out at 12pm today. However, her daughter came back at 2pm and noted the patient lying on the ground with vomitus, urine incontinence and twitching over left hand. She called 119 immediately and the EMT arrived 10 minutes later.

Part D. Situation section: Does the patient have stroke onset within three hours?

Situation 1: A 48-year-old man, without any specific systemic disease, had sudden onset of slurred speech, mouth deviation and can't hold the chopsticks by his right hand when he had his breakfast at 7:30am today. His family called 119 at 8am and the EMT arrived 10 minutes later.

Situation 2: A 70-year-old man, who had hypertension and cigarette use history, had numbness and clumsiness over left arm at 10pm last night. He went to sleep at first. However, he had aggravated numbness over left face and extremities when he woke up at 5am today. He could not raise his left arm and leg, neither. He called 119 immediately and the EMT arrived 10 minutes later.

Situation 3: A 68-year-old lady, who had stroke history with residual left paralysis, but could still walk with standard walker use. She went to restroom by herself at 10am. However, her family noted her sitting on the commode with consciousness disturbance. She could not talk and had significant weakness over right side extremities (in comparison with previously-weak left side). Her family called 119 immediately and the EMT arrived 10 minutes later.

Situation 4: An 85-year-old lady, with arrhythmia history, was quite normal when she went to bed at 9pm last night. Her grandson went out before the patient got up at 8am today. However, he came back and noted the patient lying on the bed with consciousness disturbance at 12pm. He called 119 immediately. The EMT arrived 10 minutes later and found the patient had flaccid right extremities.

Situation 5: A 66-year-old lady complained numbness of right upper extremity and clumsy right hand while typing at 1pm today. She also had unsteady gait with deviation to right side. She called 119 immediately and the EMT arrived 10 minutes later.

assess the accuracy of acute stroke identification within 3 hours of symptom onset, as well as the ability to separate stroke from common stroke-mimic events (e.g., hypoglycemia or seizure).

EMTs were requested to complete the same test before, immediately after, and 3 months after the educational program. To compare the baseline stroke knowledge and triage accuracy of dedicated EMS providers with that of other medical personnel, a group of nurses were recruited to complete the same test. The test questions are listed in Table 1.

Outcome Measures

The effectiveness of educational intervention was evaluated from the comparison of the scores of the pretest, posttests immediately after the class and 3 months later. Every correct answer was scored, including multiple-choice questions (one point for each item). The total score was 39 points. We also asked the participants to fill in their personal profiles, including age, gender, how long they worked in EMS teams. They also had to answer some basic questions, listed in Table 3, to see if they ever attended other stroke educational program, and the working experience of transporting stroke patients.

Table 2. Demographics of dedicated EMS responders (n=33)

Variables	Total (N=33)
Gender	
Male	30 (91%)
Age group (years)	
20-29	10 (30%)
30-39	22 (67%)
40-49	1 (3%)
Age (year, mean ± SD)	31.3 ± 14.6
EMS experience (year, mean ± SD)	8.4 ± 4.1
EMS experience	
1-9 years	52%
10-19 years	48%
EMT level	
EMT I	
EMT II	26 (79%)
EMT P	7 (21%)

SD: standard deviation; EMS: emergency medical service; EMT: emergency medical technician.

We provided the educational program to another nursing staff group and asked them to complete the pretest, too. We examined the difference of the scores between the two groups.

Statistical Methods

Baseline dichotomous demographic variables are presented as percentages and compared using chi-square test and Fisher's exact test whenever indicated. Continuous variables are shown as the mean (±standard deviation [SD]). To test the significance of differences in continuous variables between two groups, Student's *t*-test was used whenever indicated. Wilcoxon signed-rank test was used to compare scores pre- and post-intervention (i.e., the completion of the educational program) for each subject. Multiple linear regressions were used to determine whether baseline demographic factors affected the total pretest score or difference between pre-intervention and immediate post-intervention total score. Statistical analyses were performed using SPSS 17.0 for Windows.

RESULTS

A total of 33 dedicated EMS responders participated in the educational program and completed both the pretest and immediate posttest. Another fifteen responders did not attend the program because of duty. Twenty-one of the trainees also completed the 3 month posttest. The baseline characteristics of the 33 providers are presented in Table 2. Briefly, most were males (91%) and EMT-IIs (79%). About 50% of them had 1-9 years of EMS experience and the rest had 10-19 years.

Analysis of the responses to our basic questions (Table 3) revealed that 97% of participants had previously transported acute stroke patients to hospitals while on duty. Though only 48% of them had any formal training about how to evaluate acute stroke patients, 97% of them knew that acute stroke patients need emergent medical evaluation and management, and more than 90% of them had heard about the "thrombolytic agent for AIS" and "golden 3-hour" window.

As shown in Table 4, total scores before attending

Table 3. Responses of the dedicated EMTs (n=33) to the basic questions

Item	Yes (%)	No (%)
Have your relatives or friends ever experienced stroke?	48	52
Have you ever transported an acute stroke patient to a hospital while on duty?	97	3
Have you ever attended any training class about how to evaluate acute stroke patients?	48	52
Do you know that acute stroke patients need emergent medical evaluation and management?	97	32
Have you ever heard of the “thrombolytic agent”-- tissue plasminogen activator?	100	0
Have you ever heard of the “golden 3-hour” window?	94	6

Table 4. Comparison of pretest scores in dedicated EMS providers (N=33) and nurses (N=34), and the scores of immediate posttest and posttest three months later in dedicated EMS providers

Test section (score)	Dedicated EMS staff Pretest (N=33)	Nurses (N=34)	P-value†	Immediate posttest (mean±SD)	P-value‡	Posttest at 3 months (mean±SD)	P-value‡
True-false (10)	9.1±0.8	8.9±0.9	0.256	9.4±0.7	0.057	9.0±0.9	0.527
Choice (19)	15.7±1.9	17.8±2.1	<0.001	18.0±1.4	<0.001	17.7±1.2	<0.001
Video (5)	4.7±0.7	4.8±0.5	0.277	5.0±0.2	0.026	4.8±0.4	0.190
Situation (5)	4.7±0.6	4.8±0.5	0.624	4.9±0.3	0.107	4.9±0.4	0.096
Video + situation (10)	9.4±1.0	9.6±0.7	0.290	9.9±0.3	0.009	9.7±0.5	0.058
Total score (39)	34.2±2.2	36.3±2.4	<0.001	37.3±1.7	<0.001	36.4±1.9	0.002

SD: standard deviation

†P-value is obtained using Student’s t-test

‡P-value is obtained using Wilcoxon signed-rank test

Table 5. Results of multiple linear regressions in model 1 and model 2

	Model 1			Model 2		
Variables	β	95% CI	p-value	β	95% CI	p-value
Constant	21.7	7.5~35.8	0.004	36.7	22.0~51.3	<0.0001
Gender	0.8	-2.7~4.3	0.627	-0.1	-3.2~2.9	0.928
Age	0.1	-0.3~0.4	0.717	0.2	-0.1~0.5	0.290
Seniority	-0.1	-0.6~0.3	0.597	-0.2	-0.6~0.2	0.320
EMT*	1.5	-1.3~4.2	0.278	0.6	-1.9~3.0	0.639
Basic 1	-0.1	-2.3~2.0	0.912	-0.3	-2.1~1.6	0.753
Basic 2	2.9	-2.1~7.9	0.242	-0.6	-5.0~3.9	0.798
Basic 3	0.2	-1.8~2.3	0.810	0.4	-1.4~2.2	0.647
Basic 4	3.8	-2.1~9.6	0.197	-0.2	-5.4~5.1	0.950
Basic 6	1.0	-2.7~4.7	0.588	0.8	-2.5~4.0	0.622
Pretest total score	NA	NA	NA	-1.1	-1.5~-0.7	<0.0001

Model 1: dependent variable = pretest total score

Model 2: dependent variable = difference=(posttest total score-pretest total score)

*EMT-P vs. EMT-II, while EMT-II as a reference

the program were 34.2±2.2 (full total score: 39). Compared with nursing staff (n=34), the dedicated EMS staff had lower choice section score (15.7±1.9 vs. 17.8 ±2.1, p<0.001) and total score (34.2±2.2 vs. 36.3± 2.4, p<0.001), but not true-false, video, situation, and video plus situation section scores.

Pretest and immediate post-test scores are presented in Table 4. Performance (true-false, choice, video, and total scores) improved significantly. The situation score also increased, without statistical significance (4.7±0.6 vs. 4.9±0.3, p=0.107).

Twenty-one participants completed the 3-month post-test (Table 4). The 3-month choice score (15.8± 1.7 vs. 17.7±1.2, p<0.001) and total score (34.1±2.2 vs. 36.4±1.9, p=0.002) remained significantly higher than their corresponding pretest counterparts.

The results of multiple linear regressions are shown in Table 5. The dependent variable was the pretest score in model 1 and the difference between pretest and immediate posttest in model 2. No baseline demographic factors (including age, gender, work year, etc.) and responses to basic questions were identified as predictors of pretest score in model 1. There was a negative correlation between pretest total score and the difference in immediate and pretest total scores in model 2 (β=-1.1; 95% CI, -1.5~-0.7, p<0.0001).

DISCUSSION

A literature review indicates that educational programs for paramedics improves their sensitivity to stroke identification and reduces time to treatment[5-11]. Stroke education is often not provided and not a prerequisite for EMS certification or continuing education in Taiwan. In our study, less than half of examinees (48%) had previously attended a training program that showed how acute stroke patients should be evaluated. We demonstrated an educational program to improve paramedic diagnosis of stroke within three hours of symptom onset. So far, our educational program is the first citywide EMS training program constructed by inter-hospital cooperation in Taiwan.

In the present study, baseline demographic factors and experience were not determinants of the total pretest score. Compared to non-dedicated EMS responders, dedicated responders (79% EMT-II and 21% EMT-P) should have more knowledge and experience of emergency management of stroke. This may explain their high pretest score (mean score: 34.2, total full score: 39) and similarity of their pretest performance to that of nurses except in the choice section. Despite this good baseline performance, we were still able to detect significant improvement in total stroke knowledge and triage accuracy scores immediately after the educational intervention (34.2±2.2 vs. 37.3±1.7, p<0.001) and 3 months after the educational intervention (34.1±2.2 vs. 36.4± 1.9, p=0.002).

Our educational program significantly improved the accuracy of identifying stroke onset within 3 hours in dedicated EMS responders (4.7±0.7 vs. 5.0±0.2, p=0.026). Tools such as the Cincinnati Pre-hospital Stroke Scale (CPSS)[12] and Los Angeles Pre-hospital Stroke Screen (LAPSS)[13] have been used by EMS systems to identify stroke patients in the field. Though the sensitivity and specificity of those tools were more than 90% for the diagnosis of acute stroke, stroke onset time was not determined[12,13]. Consequently, new scales and protocols were developed for screening potential candidates for thrombolytic therapy, such as the Emergency Triage Stroke Scale (ETSS)[14], which is a one-page condensed version of the National Institute of Health Stroke Scale (NIHSS). Although the Taiwan Triage and Acuity Scale (TTAS)[15] developed by our Department of Health in 2010, stroke patients should be triaged as level 2 if the onset time is less than 3 hours and as level 3 if onset time is more than 3 hours. Thus, establishing the time of stroke onset is very important for the EMS staff because it will affect decisions regarding triage and emergency transportation. However, no details regarding stroke triage are described in TTAS and a stroke scale should not only identify acute stroke but also onset time in order for the EMS to transport in a timely manner for AIS patients who may be eligible for thrombolytic therapy. A simple screening checklist may be a more efficient and sensitive tool than the scales mentioned above.

The situation score was the only sub-score not sig-

nificantly improved by the educational program (4.7±0.6 vs. 4.9±0.3, p=0.107, maximum situation score: 5). High baseline score on this section of the test may account for the lack of significance. Several conditions, like seizure and hypoglycemia, can also cause weakness and could be confused with acute stroke symptoms. Results of the video section of the test showed that the program helped dedicated EMS responders distinguish those conditions from acute stroke. A stroke scale developed for EMS providers should contain items excluding seizure and abnormalities of blood sugar.

Our study had several limitations. First, power was limited due to small sample size (n=33). Duties of the EMS prevented more staff members from attending the program. Second, only dedicated EMS providers were included and there were only 6 such teams in Tainan city. However, despite the small sample size, there was an effect (total score increased significantly after the educational program). Third, because the implementation of this educational program for the EMS and in medical centers to make better use of thrombolytics was urgent in Tainan city, we didn't check the validity and reliability of the survey questions, and this failure may have affected the accuracy of our findings.

In conclusion, via this pilot study, our education program for dedicated EMS staffs had improved their knowledge about stroke and their ability to identify cases of acute stroke within 3 hours of symptom onset. The effect persisted after 3 months after the educational program. Such educational program could be promoted in non-dedicated EMS teams in Tainan City, and elsewhere in Taiwan, also in other paramedic staffs and general population ultimately. Further investigations are warranted to determine the accuracy of stroke identification in the field and the potential benefit of early pre-hospital notification of stroke patients within 3 hours of onset to increase the rate of thrombolytic therapy.

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