Lack of Association Between Stroke Symptom Knowledge and Intent to Call 911
A Population-Based Survey

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Background and Purpose—Excessive prehospital delay between acute stroke onset and hospital arrival is an ongoing problem. Translating knowledge of stroke warning signs into appropriate action is critical to decrease prehospital delay. Our objectives were to estimate the proportion of Michigan adults who would react appropriately by calling 911 when presented with hypothetical stroke-related scenarios and to examine the association between knowledge of warning signs and calling 911.

Methods—In 2004, questions regarding initial response to health-related scenarios were added to the Michigan Behavioral Risk Factor Survey, a population-based telephone survey of adults. We calculated the proportion of respondents who would call 911 in response to 3 stroke-related scenarios and examined the association between stroke warning sign knowledge and 911 activation.

Results—Among 4841 adults, 27.6% (95% CI, 26.2 to 29.0) had adequate knowledge of stroke warning signs (defined as reporting 3 correct warning signs), and 14.0% (95% CI, 12.9 to 15.1) reported they would call 911 for all 3 stroke-related scenarios. Knowledge of specific stroke warning signs was only modestly associated with calling 911 in response to medical scenarios that involved the same stroke symptom (OR, 1.17 to 1.39). Even among those with adequate knowledge of stroke warning signs, only 17.6% (95% CI, 15.5 to 20.0) would call 911 for all 3 stroke scenarios.

Conclusions—In this population-based survey, stroke symptom knowledge was not associated with the intent to call 911 for stroke. This study emphasizes the critical role of motivation in addition to symptom knowledge to reducing delay time to hospital arrival for stroke. (*Stroke*. 2010;41:00-00.)

Key Words: emergencies ■ EMS activation ■ knowledge ■ stroke

S troke is the third leading cause of death in Michigan and the United States.[1,2] Although recombinant tissue plasminogen activator treatment for acute stroke has been available since 1996, its use remains poor.[3] The single most important reason for why patients with acute stroke do not receive recombinant tissue plasminogen activator treatment is delayed arrival to the hospital.[4,5] The American Heart Association advises that calling 911 should be the first and only response to suspected stroke symptoms,[6] because the use of emergency medical services (EMS) is consistently associated with earlier arrival, faster triage, and greater recombinant tissue plasminogen activator use.[3,4,7–10]

A widely held assumption is that efforts to increase public awareness of stroke warning signs will lead to earlier recognition, activation of EMS, and reduced prehospital delay.[6,11] However, it has been recognized that increasing knowledge of symptoms may be insufficient and that behavioral change interventions focusing on motivation are needed to promote rapid calling of 911.[7,8,12] Activation of EMS involves a complex "knowledge-to-action" process that requires several steps: (1) adequate knowledge of stroke warning signs; (2) proper recognition and interpretation of warning signs; (3) awareness of the need to activate EMS; and (4) calling 911.[7,8,13] Motivation to call 911 can be promoted by increasing positive outcome expectations, self-efficacy and perceived peer norms, and by minimizing barriers to EMS access.[7,12,14,15]

Studies have shown that public knowledge of stroke warning signs has increased over recent years,[16,17] but despite this, delays in seeking treatment for stroke remain common.[4,5,7,9,18] Only a few studies have investigated the association between stroke knowledge and activating 911 in nonstroke-affected populations.[11,13,14,19] These studies found that between 14% and 72% of participants reported that they

would call 911 in response to specific stroke-related symptoms.[11,13,14,19] Our study furthers this work by using data from a population-based survey to estimate the proportion of adults who, when presented with stroke-related symptoms, would react appropriately by calling 911. In addition, we examine the association between knowledge of specific stroke warning signs and response to stroke scenarios that incorporate each warning sign.

Materials and Methods

The Behavioral Risk Factor Surveillance System comprises annual, state-level, random-digit-dialed telephone surveys of adults conducted in cooperation with the Centers for Disease Control and Prevention.[20] The Michigan Behavioral Risk Factor Surveillance System (MiBRFSS) is a component of this national surveillance system, the purpose of which is to provide population-level estimates of health behaviors, knowledge, and awareness. Willingness to complete the Behavioral Risk Factor Surveillance System questionnaire acted as an informed consent for all MiBRFSS participants.

To assess 911 activation, respondents to the 2004 MiBRFSS were asked how they would respond to 5 hypothetical health-related scenarios, 3 of which were specific to stroke. The questions were constructed as follows: "Next, I'm going to describe several health-related situations. For each one, please tell me what you would be most likely to do *first* after you evaluated the person's condition. If an adult family member or friend [insert scenario], would you most likely give them some medicine or first aid, call their doctor, take them to an emergency room, call 911, stay with them until they felt better, or something else?" The 5 health-related scenarios were presented in the following order: (1) "suddenly had trouble speaking or understanding what was being said"; (2) "fell and injured their leg so they had trouble walking on it"; (3) "suddenly had trouble seeing in 1 or both eyes"; (4) "developed a high fever"; and (5) "had sudden numbness or weakness on 1 side of the body." Two scenarios (No. 2 and 4) were included to provide an estimate of EMS activation for nonstroke-related symptoms. Calling 911 was regarded as the only correct answer, and respondents could provide only 1 response. We defined "adequate intent to call 911" as reporting that they would call 911 for all 3 stroke-related scenarios and "inadequate intent to call 911" as reporting that they would *not* call 911 for any of the scenarios.

As has been previously described,[17] an open-format question assessing knowledge of stroke warning signs was also included in the 2004 MiBRFSS, that is, "Next, I would like to ask you about warning signs for stroke, that is, what are the first symptoms or signs that someone is having a stroke. From anything you might have read or heard, what do you think are the 3 most important signs of a stroke?" This question was asked after the health-related scenario questions. Correct responses were defined according to definitions used by the American Heart Association.[6,17] We defined adequate knowledge of stroke warning signs as being able to report 3 correct stroke warning signs.[17]

All statistical analyses were performed using SAS-Callable SUDAAN to account for the complex survey design.[21] Data were weighted to account for the probability of selection and poststratified to the Michigan adult population by age, race, and sex. For each of the 5 health scenarios, proportions with 95% CIs were generated for each response category. For each of the 3 stroke scenarios, χ^2 analyses were used to test for statistical associations between demographic factors and calling 911. We also examined associations among demographic factors, stroke knowledge, and the intent to call 911 (both adequate and inadequate). Selected pairwise comparisons were calculated for each of the 3 stroke scenarios as well as for the intent to call 911. To determine whether knowledge translated into appropriate action, we calculated adjusted ORs for the association between having knowledge of each of the 3 specific stroke warning signs and calling 911 for each corresponding stroke-related scenarios (ie, No. 1, 3, and 5, respectively). Adjusted ORs were generated

using multivariable logistic regression models that also included age, sex, race, education, and income.

Results

A total of 4841 MiBRFSS respondents completed the stroke-related questions. The response rate for the 2004 MiBRFSS was 48.4%.[22]

Responses to the 5 health scenarios are shown in Figure 1. Just over half of respondents (51.5%) would call 911 as their initial response if a family member or friend presented with sudden trouble speaking or understanding (Scenario 1), 42.0% reported they would call 911 if a family member or friend had sudden numbness or weakness on 1 side of the body (Scenario 5), but only 20.4% of respondents reported that their initial response would be to call 911 when presented with a family member or friend who had sudden trouble seeing out of 1 or both eyes (Scenario 3). For the nonstroke scenarios, 26.9% of respondents reported that they would call 911 if a family member or friend had fallen and injured their leg so they had trouble walking on it (Scenario 2), and only 5.0% of respondents reported that they would call 911 if a family member or friend had a high fever (Figure 1). Except for Scenario 1, "take them to the emergency room" was the most common response to the health scenarios (Figure 1). For the 3 stroke scenarios, a total of 78.7%, 72.3%, and 87.0% of respondents, respectively, reported either calling 911 or taking the person to the emergency room.

The proportion who reported calling 911 in response to each of the 3 stroke scenarios by demographic characteristics is shown in Table 1. For each stroke scenario, the probability of calling 911 increased significantly ($P<0.01$) with age. Females were slightly more likely than males to call 911 in response to sudden trouble speaking or understanding what is being said (53.7% versus 47.9%), but sex was not associated with calling 911 for the other 2 scenarios. White non-Hispanic ($P<0.01$) and black non-Hispanic ($P<0.01$) respondents were more likely than Hispanics to call 911 in response to sudden trouble speaking or understanding what is being said, whereas black non-Hispanic respondents were more likely than white non-Hispanics ($P=0.001$) and Hispanics ($P=0.05$) to call 911 in response to sudden trouble seeing in 1 or both eyes. Education was significantly associated with calling 911 in response to sudden trouble speaking or understanding only. Those with at least some college education were less likely to call 911 compared with those with a high school education or less ($P<0.01$). There was no association between household income and the intent to call 911.

Only 14.0% (95% CI, 12.9 to 15.1) of respondents had adequate intent to call 911, that is, reported that they would call 911 for all 3 stroke-related scenarios, whereas 37.1% had inadequate intent, that is, reported they would *not* call 911 for any of the 3 stroke scenarios (Table 2). A further 26.9% and 22.0% of respondents reported that they would call 911 for either 1 or 2 stroke scenarios, respectively (data not shown). The proportion of subjects with adequate intent to call 911 was associated with age ($P<0.001$). The proportion was lowest (6.1%) in those aged 18 to 24 years and increased to 17.6% in those aged 65 to 74 years. There were no significant relationships between sex, race, education, or insurance and adequate
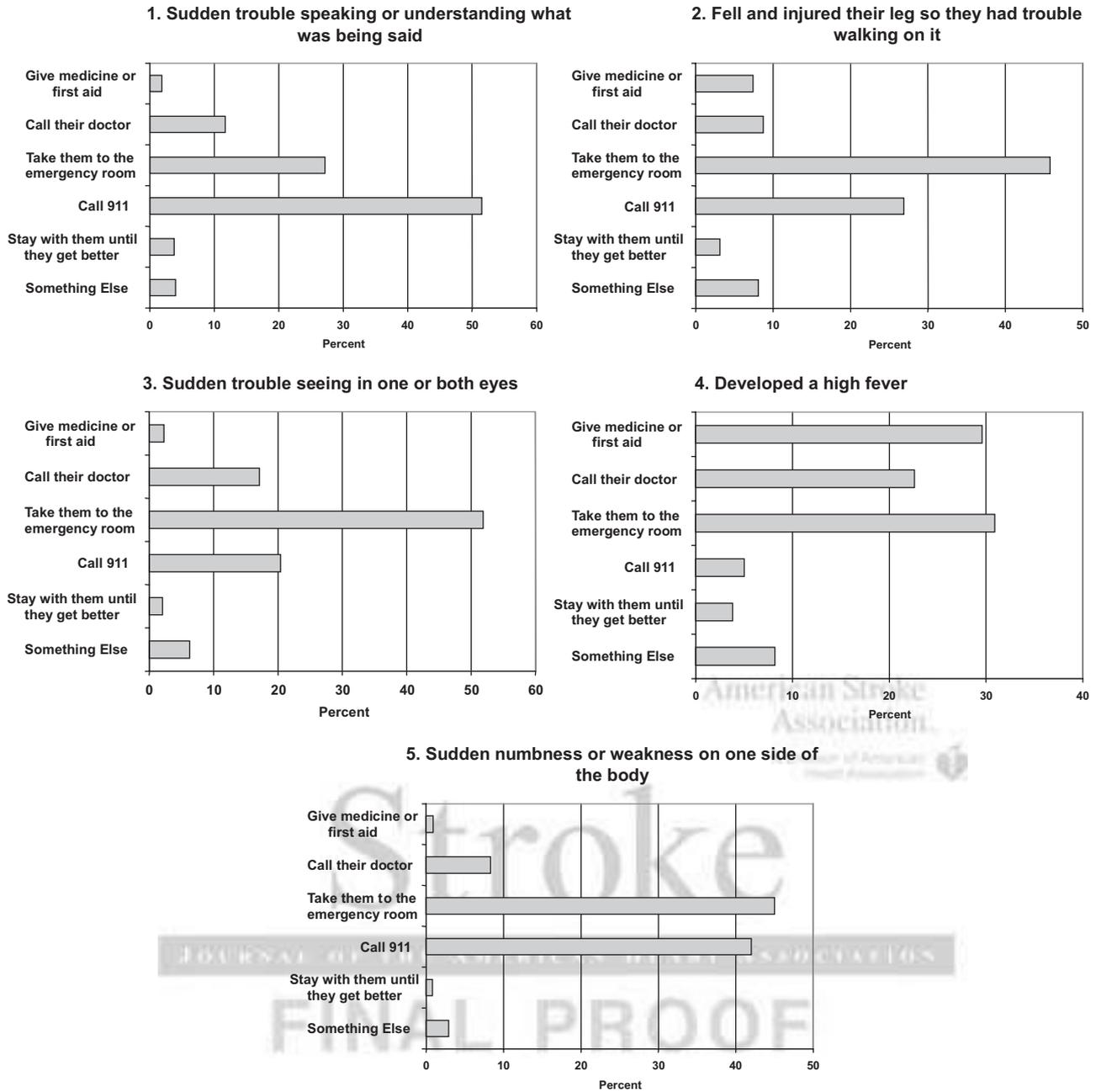
1. Sudden trouble speaking or understanding what was being said

2. Fell and injured their leg so they had trouble walking on it

3. Sudden trouble seeing in one or both eyes

4. Developed a high fever

5. Sudden numbness or weakness on one side of the body

Figure 1. The percent distribution of initial responses to health-related medical scenarios, 2004 MiBRFSS.

intent to call 911 (Table 2). The proportion of subjects with inadequate intent to call 911 was associated with age ($P<0.001$), sex ($P=0.01$), and education level ($P<0.001$).

Although there was a positive association between knowledge of stroke warning signs and adequate intent to call 911 ($P=0.001$), the proportions were low (Table 2). Only 17.6% of those with adequate knowledge of stroke warning signs (ie, 3 correct responses) reported that they would call 911 for all 3 stroke scenarios compared with 12.1% of those with no correct responses.

Figure 2 shows the relationship between a respondent's knowledge of a specific warning sign and whether they would call 911 in response to the same specific symptom. Overall, there were only modest associations between knowledge of

specific warning signs and calling 911. The odds of calling 911 when presented with a friend or family member with sudden trouble speaking or understanding what is being said were 39% higher in subjects who were able to identify this symptom as a warning sign of stroke (adjusted OR, 1.39; 95% CI, 1.19 to 1.62). The odds of calling 911 were also modestly higher for sudden trouble seeing in 1 or both eyes when the respondent was knowledgeable about this specific warning sign (adjusted OR, 1.39; 95% CI, 1.13 to 1.70) and with sudden numbness or weakness on 1 side of the body (adjusted OR, 1.17; 95% CI, 1.00 to 1.38).

Discussion

The results from this population-based study indicate that only 14% of Michigan adults would react appropriately by

Table 1.   Calling 911 in Response to Stroke-Related Medical Situations, 2004 MiBRFSS

	Sudden Trouble Speaking or Understanding What Is Being Said*			Sudden Trouble Seeing in 1 or Both Eyes†			Sudden Numbness or Weakness on 1 Side of Their Body‡		
	Percent	95% CI	P§	Percent	95% CI	P§	Percent	95% CI	P§
Total	51.5	(49.8–53.1)		20.4	(19.1–21.7)		42.0	(40.4–43.7)	
Age, years			<0.001			<0.001			<0.01
18–24	36.1	(30.4–42.3)		11.6	(8.1–16.3)		31.4	(26.0–37.3)	
25–34	46.0	(41.5–50.6)		19.2	(15.8–23.3)		40.4	(35.9–45.0)	
35–44	51.1	(47.5–54.7)		20.1	(17.3–23.3)		42.4	(38.8–46.0)	
45–54	52.7	(49.3–56.1)		20.8	(18.1–23.7)		45.4	(42.0–48.8)	
55–64	56.7	(52.9–60.3)		25.2	(22.1–28.7)		45.5	(42.0–48.8)	
65–74	63.1	(58.9–67.1)		23.3	(19.9–27.0)		44.6	(40.5–48.9)	
75+	57.3	(52.5–61.9)		22.2	(18.6–26.3)		41.1	(36.6–45.7)	
Sex			<0.001			0.44			0.10
Male	47.9	(45.3–50.6)		20.7	(18.6–22.9)		40.3	(37.8–42.9)	
Female	53.7	(51.6–55.8)		19.6	(18.1–21.3)		43.0	(41.0–45.1)	
Race/ethnicity			<0.01			0.01			0.30
White non-Hispanic	51.3	(49.5–53.1)		19.0	(17.7–20.4)		41.9	(40.2–43.7)	
Black non-Hispanic	54.7	(49.1–60.2)		27.6	(22.9–32.8)		43.7	(38.2–49.3)	
Other non-Hispanic	43.7	(33.7–54.2)		23.3	(15.6–33.4)		34.1	(25.2–44.3)	
Hispanic	33.7	(24.9–43.8)		18.4	(11.8–27.5)		36.9	(27.7–47.3)	
Education			<0.001			0.98			0.10
Less than high school	52.0	(45.8–58.1)		20.6	(16.0–26.2)		40.8	(34.9–47.0)	
High school graduate	56.5	(53.5–59.4)		20.3	(18.1–22.7)		44.1	(41.2–47.1)	
Some college	48.0	(44.9–51.1)		19.7	(17.3–22.3)		42.2	(39.2–45.3)	
College graduate	47.9	(45.0–50.7)		20.3	(18.1–22.8)		39.1	(36.3–41.9)	
Household income			0.62			0.27			0.48
<$20 000	54.0	(49.4–58.4)		21.9	(18.4–25.8)		41.4	(37.1–45.9)	
$20 000–$34 999	50.1	(46.4–53.8)		17.7	(15.1–20.7)		39.9	(36.3–43.6)	
$35 000–$49 999	49.7	(45.5–53.9)		20.7	(17.5–24.5)		43.3	(39.1–47.6)	
$50 000–$74 999	50.1	(46.1–54.1)		18.3	(15.5–21.6)		41.0	(37.1–44.9)	
$75 000+	49.8	(46.3–53.3)		21.0	(18.2–24.0)		44.2	(40.7–47.7)	

*The proportion who reported that calling 911 would be the first thing they would do if a family member or friend suddenly had trouble speaking or understanding what was being said.

†The proportion who reported that calling 911 would be the first thing they would do if a family member or friend suddenly had trouble seeing on 1 or both eyes.

‡The proportion who reported that calling 911 would be the first thing they would do if a family member or friend had a sudden numbness or weakness on 1 side of their body.

§P based on χ^2 test.

first calling 911 when presented with 3 different stroke-related scenarios. Although the percentage of adults with adequate intent to call 911 increased with age, it was <20.0% in all groups. Our results fall into the lower end of the range reported by other studies of nonstroke-affected populations.[11,13,14,19] The study by Billings-Gagliardi reported that lay people chose to call 911 for 34.1% of the stroke-related symptoms included within the Stroke Action Test questionnaire.[14] A study from Australia reported that between 5% and 20% of respondents would call 911 in response to various stroke symptoms.[11] In 2 recent US studies, the intention to call 911 in response to specific stroke symptoms was higher; a survey conducted in upstate New York found that between 33% and 72% of respondents would call 911 depending on the specific stroke symptom described,[13] whereas a survey in Montana found that between 41% and 51% of respondents

would call 911 depending on the specific stroke symptom.[19] Other studies have been conducted in stroke-affected patients,[10,23–25] and within these populations, calling 911 in response to stroke symptoms also remains poor (range, 26.1% to 38.0%).

Our study found that in 4 of the 5 health-related scenarios, taking the patient to the emergency room was the most common response. When combined with calling 911 for the 3 stroke scenarios, the actions of between 72% and 87% of respondents would result in the subject being taken to the hospital. Although these data clearly indicate that respondents are aware of the emergent nature of stroke, these data illustrate a problem in that the public appears to be unaware of the advantages of EMS transport and the fact that public health recommendations advise the use of EMS over private transport. The clear benefits of EMS transport on earlier

Table 2. Prevalence of Adequate and Inadequate Intent to Call 911 as the First Response to 3 of the Stroke-Related Medical Scenarios,* 2004 MiBRFSS

	Adequate Intent (Call 911 for All 3 Scenarios)			Inadequate Intent (Do Not Call 911 for Any of the 3 Scenarios)		
	Percent	95% Confidence Interval	P†	Percent	95% Confidence Interval	P†
Total	14.0	(12.9–15.1)		37.1	(35.5–38.8)	
Age, years			<0.001			<0.001
18–24	6.1	(3.8–9.8)		50.7	(44.5–56.8)	
25–34	12.8	(9.9–16.5)		39.5	(35.1–44.0)	
35–44	15.2	(12.7–18.1)		37.5	(34.1–41.0)	
45–54	14.6	(12.4–17.1)		35.9	(32.7–39.2)	
55–64	17.3	(14.5–20.4)		31.0	(27.7–34.6)	
65–74	17.6	(14.7–21.0)		28.9	(25.2–32.9)	
75+	15.2	(12.2–18.7)		32.4	(28.2–37.0)	
Sex			0.84			0.01
Male	13.8	(12.2–15.7)		39.3	(36.8–41.9)	
Female	14.1	(12.7–15.6)		35.2	(33.2–37.2)	
Race/ethnicity			0.11			0.05
White non-Hispanic	13.6	(12.4–14.8)		37.3	(35.6–39.0)	
Black non-Hispanic	18.6	(14.7–23.2)		32.5	(27.5–38.0)	
Other non-Hispanic	13.3	(7.9–21.4)		44.9	(34.7–55.6)	
Hispanic	10.5	(5.7–18.4)		46.3	(36.3–56.6)	
Education			0.59			<0.001
Less than high school	13.2	(9.6–18.0)		35.2	(29.5–41.4)	
High school graduate	15.0	(13.1–17.2)		32.3	(29.6–35.2)	
Some college	13.1	(11.1–15.3)		38.4	(35.4–41.5)	
College graduate	14.0	(12.1–16.1)		41.4	(38.6–44.2)	
Insurance coverage			0.71			0.67
Yes	14.1	(13.0–15.3)		37.2	(35.5–38.9)	
No	13.4	(10.0–17.6)		36.0	(30.8–41.6)	
Knowledge of stroke warning signs‡			0.001			<0.01
No correct responses	12.1	(9.6–14.1)		43.0	(38.7–47.4)	
1 correct response	11.5	(9.4–14.1)		38.2	(34.5–42.0)	
2 correct responses	13.7	(11.9–15.7)		36.1	(33.4–38.9)	
All 3 correct responses	17.6	(15.5–20.0)		33.6	(30.9–36.4)	

*The proportion who reported that they would most likely call 911 first in response to all 3 or none of the following medical situations: (1) if a family member or friend suddenly had trouble speaking or understanding what was being said; (2) if a family member or friend suddenly had trouble seeing on 1 or both eyes; or (3) if a family member or friend had a sudden numbness or weakness on 1 side of their body.

†P based on χ^2 test.

‡Correct stroke warning signs included any weakness or numbness, confusion, or trouble speaking or understanding speech, trouble seeing, trouble walking, dizziness or loss of balance, and severe headache.

arrival, faster triage and greater recombinant tissue plasminogen activator use[3,4,7–10] need to be better articulated to the public.

Although this study found that knowledge of specific stroke warning signs resulted in significant increases in the odds of calling 911, the associations were only modest (adjusted ORs, 1.17 to 1.39). These results are consistent with previous studies that have shown little or no association between knowledge and the intention to call 911 in population-based studies[11–14,26] or between knowledge and calling 911 in clinical populations with stroke symptoms.[8,10,23–25] For example, a prospective study conducted on 617 patients who arrived in the emergency department with stroke symptoms found that knowledge of stroke symptoms was associated with less EMS activation (OR, 0.63; 95% CI, 0.40 to 0.98).[8] Our findings add to these results by indicating that a disconnect remains between knowledge of stroke warning signs and the intent to call 911 in response to these signs.

To address deficits in the public's knowledge of stroke warning signs and the need to call 911 for stroke, several community-based educational interventions have been conducted.[12,26–29] It has been recommended that community-level interventions target outcome expectations, stroke recognition skills, and perceived community norms with the intent of increasing the motivation to call 911 quickly.[7,12,26] To change behavior in favor of calling 911 immediately after
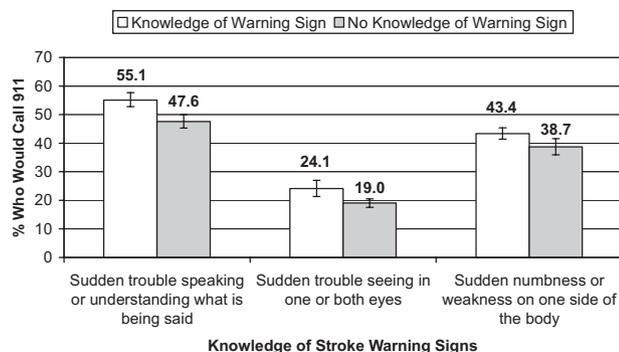
Figure 2. The percentage of respondents who reported that they would call 911 in response to each specific stroke-related medical scenario by knowledge of that specific warning sign.

witnessing a stroke symptom requires several complimentary elements to be in place, including not only adequate knowledge of stroke symptoms, but also the belief that calling 911 will result in better outcomes and the removal of barriers that prevent action such as costs and the embarrassment of having an ambulance outside one's house. We use the term "motivation" to describe these crucial elements of self-efficacy, outcome expectations, and barrier removal as have other previous investigators.[12,15] To increase motivation, educational efforts should aim to reduce the level of fear associated with stroke and to motivate the public to respond quickly to stroke symptoms by connecting rapid response to improved health outcomes.[12,26,28,29] Based on the results of our study, we suggest that education efforts also be directed toward explaining the benefits of EMS transport compared with private transport in maximizing appropriate acute stroke care. It is essential that these interventions have a communitywide focus because family members and friends are much more likely to call 911 than stroke-affected subjects themselves.[24,30] Educational interventions undertaken at the healthcare provider level should reinforce community-level interventions[12,26] and include efforts to increase the level of trust among patients, providers, and EMS workers. To increase the effectiveness of community-based stroke intervention studies, further research is required to better understand the roles of social, cognitive, and emotional factors that contribute to prehospital delay.[7] In particular, studies that address the influence of factors such as denial, embarrassment, cost, and cultural attitudes on the motivation to call 911 are urgently needed.

The limitations of this study include those commonly associated with cross-sectional telephone surveys, which include the potential for noncoverage bias (exclusion of people who live in cell phone-only households and those who do not live in private residences) and nonresponse bias.[20] The potential for noncoverage bias in random-digit-dial telephone surveys has been increasing as cell phone-only households have become more prevalent, especially among younger adults and low-income households.[31] In our study, because age was consistently associated with the intent to call 911, our estimate for adequate intent may in fact be a slight overestimate of the true prevalence. We also note that the data on stroke symptom knowledge is generated from open-ended

questions, an approach that results in an underestimate of stroke knowledge compared with closed-ended questions. However, we believe that this approach provides a more accurate reflection of actionable knowledge. Finally, this study focused on the responses to only 3 stroke warning signs; other stroke warning signs such as sudden problems with walking and severe headache were not included.

In summary, this population-based study found that intention to call 911 in response to stroke-related scenarios was low, even among those with adequate knowledge of stroke warning signs. This study emphasizes the need to address the "disconnect" between recognition of stroke symptoms and appropriate action. Further community-level behavioral interventions that focus on motivating individuals to call 911 whenever stroke warning symptoms are observed are needed. Motivation to call 911 can be promoted by increasing positive outcome expectations and self-efficacy, at the same time promoting peer norms and minimizing barriers to EMS access. Public education efforts also need to stress the advantages of using EMS over private transport for patients with stroke symptoms.

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