Emergency Medical Services-Based Community Stroke Education
Pilot Results From a Novel Approach

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Background and Purpose—Although previous studies using mass media have demonstrated successful public stroke awareness campaigns, they may have been too costly for smaller communities to implement. The goal of this study was to investigate if a novel emergency medical services (EMS) -sponsored community awareness campaign could increase public stroke awareness.

Methods—This was a pre- and postintervention study with 2 phases conducted between August 2005 and July 2007. During Phase I, strategic placement of stroke education media by EMS personnel was implemented in one county over a 2-year period. Five random-digit, standardized phone surveys measuring stroke awareness were conducted with county residents to assess the campaign’s impact. In Phase II, EMS interventions and random-digit measurements were conducted in 4 additional counties with 4 counties randomly selected as controls.

Results—A pattern of increasing stroke knowledge after exposure to the EMS intervention followed by declines in the absence of the intervention was observed during Phase I. EMS interventions also demonstrated a positive effect on the stroke knowledge of residents who lived in counties exposed to the intervention during Phase II with a statistically significant (P<0.05) increase observed in the proportion of respondents that named 2 stroke risk factors and 3 symptoms in comparison to either no changes or declines in the control counties. No evidence of a positive impact on knowledge of calling 911 for stroke was observed.

Conclusion—Results of this study suggest that the public’s knowledge of stroke signs and symptoms was increased using communitywide EMS-based programs. Additional studies are needed to determine optimal methods for educating the public regarding the need to call 911 for stroke and to confirm these results in other locales. (Stroke. 2009;40:00-00.)

Key Words: community education ■ emergency medical services ■ stroke

Stroke is the leading cause of adult disability and the third leading cause of death in the United States affecting approximately 780,000 adults each year. It is also a costly disease with an estimated cost of $65.5 billion in 2008.1 Before 1996, most stroke victims could only be treated with supportive care and physical therapy. With the advent of thrombolytic therapeutics, a new mechanism for reversing the ischemic insult and reducing morbidity was introduced. Unfortunately, only 2% to 6% of eligible candidates receive such therapy due to relatively short therapeutic treatment time windows and the widespread problem of delayed patient presentation to an emergency department for care.3,4 Researchers studying this delay have found that the greatest portion of the delay resides in the prehospital interval of the event: from the onset of stroke symptoms to emergency department arrival.5,6 The main factors associated with this delay are lack of patient and public awareness of stroke signs and symptoms7-9 and failure to recognize the need to seek urgent treatment (ie, calling 911 for immediate transport to an emergency department).8,10

In an effort to mitigate this problem, community stroke education programs using mass media have been implemented in several communities and shown to be effective at both increasing public awareness of stroke11-14 and the rate of thrombolytic treatments administered to stroke victims.15 However, the cost of these successful programs may be prohibitive to smaller communities in more rural areas of the United States.16

Our goal was to implement a self-sustaining, emergency medical services (EMS) -based strategy to educate the community on stroke. EMS was chosen to implement this campaign because it is a resource available in every commu-
Study Setting

West Virginia has approximately 1.8 million residents, many of whom are much older and poorer than the rest of the nation’s citizens. West Virginia’s median age of 40.7 years ranks second in the nation. The median household income ranks 50th nationally and is over $10,000 less than the national median.17

West Virginians are at particularly high risk for developing stroke because of the high prevalence of stroke risk factors, including obesity (highest in the nation at 28% in 2002), smoking (almost 30% of adults), high blood pressure (one third of all West Virginians), and diabetes (10%). This risk has been reflected in the rate of hospitalizations for stroke by West Virginia residents, which is well above the national average (32.1 hospitalizations per 10,000 versus 27.1 per 10,000 nationally). Women account for the majority of these hospitalizations (62%) and are more likely than men to die from stroke in West Virginia.18

Given these demographic characteristics and high prevalence of individual stroke risk factors, we felt that West Virginia provided an ideal setting for examining the impact of our EMS stroke awareness program on public stroke knowledge.

Study Design

This was a prospective, observational pre- and postintervention study that examined the impact of a community EMS stroke awareness campaign on public stroke knowledge. The study had 2 phases conducted over a 2-year period (August 2005 to July 2007).

Phase I of our study encompassed both study years and had 2 main goals. The first year of Phase I focused on testing the hypothesis of our study in one West Virginia county and obtaining feedback from EMS personnel regarding program aspects that were successful and unsuccessful in meeting our overall goal (increasing public stroke knowledge). The second year of Phase I served as a long-term follow-up to study our program’s impact on public stroke knowledge over time and whether there was a relationship between the presence of our intervention in the community and a change in public stroke knowledge.

The goal of Phase II, which occurred during the second year of our 2-year program, was to add a control component to our study design to help account for historical threats to the internal validity of study results that are common to community research. A secondary goal was to further demonstrate our program’s impact in expanded settings throughout West Virginia. To accomplish these goals, 4 counties were randomly selected to conduct the EMS intervention for 1 month during the second year of the study with 4 others randomly selected to serve as controls. The 8 counties that participated in Phase II were part of a stroke pilot project conducted by the West Virginia Hospital Association that focused on working with hospitals to improve the care of patients with stroke from arrival through discharge from the hospital. It is important to emphasize that no other public stroke education efforts were being conducted by this pilot project within any of the counties that were part of this program. These 8 counties were first matched based on population size and geographic distance (ie, nonadjacent counties to prevent contamination of the intervention effect). From the 4 resulting dyads, counties were assigned to either the intervention or control group based on a coin flip.

The protocol described subsequently was identical for both study phases and was approved by the West Virginia University Institutional Review Board for the Protection of Human Subjects.

Study Protocol

Preintervention EMS Stroke Education Course

At the program outset, EMS personnel from each county completed a detailed stroke course designed by one author (T.C.), an experienced prehospital stroke treatment and care expert. To facilitate standardization of this course, a Microsoft Powerpoint (Microsoft Corporation, Redmond, Wash) slideshow was developed by the course designer (available from the authors), and each coinvestigator was trained before meeting with the EMS personnel to ensure standardized delivery of course materials.

Each educational course lasted 2 hours. During the first 30 minutes of each session, the EMS personnel received a brief overview of stroke statistics, subtypes, risk factors, symptoms, assessment techniques, available therapies with corresponding treatment time windows, and management strategies. Next, a brief overview of prior stroke community education efforts was presented along with our idea of using the EMS system to deliver the stroke education.

The assembled group was then broken into subgroups of 4 to 5 individuals and given 15 minutes to identify up to 10 educational materials (ie, posters, flyers, and so on) that could be used to educate the public in their county about stroke. Next, each subgroup was asked to spend 45 minutes discussing up to 15 strategic community locations (eg, churches, senior centers, supermarkets, mass gatherings, events, schools, voting centers, and so on) for dissemination of the educational materials previously identified. It is important to emphasize that no attempt was made by the investigators during these sessions to influence either the content of the stroke messages selected by EMS personnel or their strategic placement in the community. This decision was made for the purposes of testing the theory that EMS personnel know the most effective types of messages for reaching the communities in which they live and work. However, the investigators did stress the importance of stroke knowledge among the entire population as opposed to only those at highest risk for stroke, and several EMS personnel members who had personally experienced stroke in their families reinforced the importance of reaching the entire community with the message. Finally, the entire group rested and spent the remaining 30 minutes discussing potential problems that could occur during the dissemination of the educational materials at the identified strategic community locations, and proposed solutions were developed.

The results of these sessions were transcribed from notes taken by each subgroup recorder and the study investigators and given to 2 EMS members who volunteered to serve as liaisons for the program. These liaisons were responsible for the production and acquisition of stroke educational materials as well as coordinating their placement within the community.

Outcome Measures

Before the actual EMS intervention, we performed a preintervention random-digit telephone survey of residents to establish a baseline of each community’s knowledge of stroke. Random-digit dialing call lists were obtained from Survey Sampling, Inc (www.surveysampling.com), a global expert in survey research. Each list contained phone numbers for all residents living in the entire county, because EMS personnel designed interventions with a goal of reaching family members and friends in addition to individuals at high risk for stroke. Consecutive phone calls were made down each list until our target sample size was obtained for each county. No additional attempts were made to a particular number if no one answered on the initial attempt. Only those residents aged >18 years were included in the study, and participation was entirely voluntary.

A standardized survey form, modeled after a survey administered by Paniolo et al19 in a seminal study examining stroke awareness in the Cincinnati, Ohio, area, was used during each phone call. Respondents were asked to name the risk factors and warning signs of stroke as well as what they would do if they were with someone they thought was having a stroke. Participants were encouraged to list as many answers as possible to each of the questions, and all responses were recorded directly on the survey form. A postinter-
vention random-digit phone survey using the same method described previously was conducted at the end of the intervention periods. For Phase I only, a long-term follow-up phone call was made 5 months after cessation of the second year of the intervention in this county to assess long-term trends in stroke awareness.

EMS Intervention
During each intervention period, the county’s EMS agency provided an uninterrupted supply of stroke educational materials (ie, flyers, brochures, magnets, and verbal reminders in cases such as churches and pharmacies) to previously defined high-yield community targets.

Study Timeline
Phase I
The first educational intervention period ran for 2 consecutive months (February 2006 to March 2006) in one West Virginia county and was repeated in this same county in 1-month intervals during October 2006, December 2006, and February 2007 (Figure 1). The random-digit phone calls were made to county residents during the following months: August 2005 (Year 1 Baseline), May 2006 (Year 1 Postintervention), September 2006 (Year 2 Baseline), Late March/Early April 2007 (Year 2 Postintervention), and June/July 2007 (Long-Term Follow-up). We chose the “pulsing” approach in Year 2 because previous research has demonstrated that staggered, repeated exposure to a message prevents memory decay and thus enhances long-term retention of the message.20

Phase II
The 4 additional randomly selected West Virginia counties conducted their EMS-based interventions in May 2007 with baseline random-digit phone calls made in March/April 2007 and follow-up phone calls made in June/July 2007. Residents living in the 4 control counties were also surveyed at the exact same time.

Data Analysis
Data were entered into SPSS (Version 13.0; SPSS, Inc, Chicago, Ill) for analysis. Person’s $\chi^2$ was used to detect any significant differences in the proportion of respondents that knew to call 911 for a potential stroke victim and that could mention specific signs, symptoms, and risk factors from the baseline to postintervention periods. An a priori power analysis indicated a sample size of 145 respondents per county per survey period to yield 80% power to detect a 15% increase in the following outcome proportions from the baseline to the postintervention period: proportion mentioning call 911 for suspected stroke, proportion mentioning at least one stroke sign or symptom, and proportion mentioning at least one stroke risk factor. We also examined increases in the proportion of respondents mentioning individual signs, symptoms, and risk factors between survey periods in the Phase II expansion with an alpha of 0.05 selected as the statistically significant threshold. Accordingly, during Phase II, a positive intervention effect was denoted if there was a statistically significant increase in the proportion of residents mentioning an individual sign, symptom, or risk factor from baseline to postintervention in the intervention counties coupled with a concomitant decrease or no change in these proportions in the control counties.

Results
Demographics
The total number of residents residing in the counties exposed to our EMS intervention was 452 107, or approximately 25% of the entire West Virginia population. The county selected for Phase I had a population of approximately 85 000 individuals, 10% of whom were >65 years old. Approximately 91% of the county residents were white, which is slightly less than the rate for West Virginia (95%). Almost one third of these residents had a college education (32.4%), which is double the rate for the state (14.8%), but median income for the county was only slightly higher than the rate for West Virginia as a whole ($34 342 versus $33 993, respectively).17

With regard to Phase II, given the limited sampling frame (N=8) from which to perform randomization, there were a few demographic differences between the intervention (N=4) and control (N=4) counties after randomization. Specifically,
average population in the intervention counties was larger than in the control counties (92,560 versus 46,825, respectively, versus 33,063 for West Virginia as a whole). On average, the intervention counties also had a higher percentage of residents aged >65 years (16.98%) compared with the control counties (14.58%). All 8 counties had a proportion of individuals >65 years (14.58%), similar to the entire state (15.3%). Intervention-county residents had a higher average rate of high school graduation compared with controls (78.85% versus 72.43%) as well as college graduation (18.35% versus 17.50%), but average median household income was higher in the control counties ($36,064 versus $33,513 in the intervention counties). Racial composition did not differ between the groups with whites comprising almost 95% of the population, which is identical to the entire state of West Virginia.17

EMS Interventions

Given our rationale discussed previously for letting each EMS agency design and implement their own community intervention, EMS personnel in the intervention counties created a diverse set of educational material, including posters placed in pharmacies, shopping malls, and on local buses; bookmarks denoting the signs and symptoms of stroke distributed to local booksellers that were placed in purchased books for customers (Figure 2); and in-person interactions with community residents at unique community functions such as the opening of a county EMS center. In many cases, the EMS personnel chose to use some of the messages previously developed by such organizations as the American Stroke Association and the National Institute for Neurological Disorders and Stroke. Table 1 lists details of the various interventions designed and implemented.

The greatest lesson learned during Phase I was the importance of having a small core of EMS personnel that coordinated the entire effort on behalf of the squad. Accordingly, during Phase II, each county selected to implement the intervention designated both a stroke champion to be the main contact point for the county as well as a team leader to conduct design and implementation session with other members of the squad.
Random-Digit Survey Results

**Phase I**
A total of 724 individuals were surveyed during the 5 survey periods. Results of the phone surveys by period are shown in Figure 3. From Surveys 1 to 4, there was a significant increase ($P < 0.05$) in the proportion of respondents who mentioned calling 911 for stroke and nonsignificant increases in the proportion able to name at least one risk factor or warning sign. There were significant declines ($P < 0.05$) in all 3 study outcomes between Surveys 4 and 5 despite previous increases in these same measures between Surveys 3 and 4 during Year 2. A similar trend was noted for 2 study outcomes between Surveys 2 and 3 in which there was also no community intervention.

**Phase II**
A total of 1193 and 1182 surveys were completed in the control and intervention counties, respectively. The EMS community stroke education campaign demonstrated positive increases in the public’s knowledge of stroke among residents in the intervention counties compared with the control counties (Table 2). Specifically, the proportion of respondents in the intervention counties mentioning 5 of 10 specific stroke risk factors during the telephone survey increased in the postintervention period with a concomitant decrease from respondents in the control counties, and 3 of these increases were statistically significant. Furthermore, the proportion of respondents able to name at least one risk factor or warning sign also increased in the intervention counties (+5%) versus the control counties where it actually decreased (−0.2%). No impact on the public’s knowledge of the correct response to a potential stroke (call 911) was found from the campaign.

One intervention county in particular had notable results. In this county, there were large increases ($P < 0.01$) between survey periods in the proportion of respondents mentioning the following risk factors and signs: high cholesterol (+24%), age (+15%), lack of exercise (+13%), family history (+11%), dizziness (+12%), speech difficulties (+31%), weakness (+15%), and headache (+25%). Activities in this county included a 911 center open house where the EMS personnel gave out paraphernalia with stroke information, placed a billboard on a busy street, and ran a TV advertisement sponsored by a local hospital.

**Discussion**
Stroke awareness increased in locales where the EMS system designed and implemented a stroke education program. The greatest impact from this unique approach was the public’s increased knowledge of stroke signs and symptoms. A lesser impact on knowledge of stroke risk factors was observed.
A plethora of studies continue to demonstrate persistent gaps in the public’s knowledge of stroke signs, symptoms, and the importance of taking immediate action (calling 911) for suspected stroke.7–9,19,24–29

Although the specific methods of each particular program vary, one common thread fundamentally ties them together: the use of mass media such as newsprint, TV commercials, and radio broadcasts to deliver the message.

On the upside, all of these programs have demonstrated a positive benefit on both stroke knowledge and behavior. However, on the downside, the problem with these mass media strategies for a locale such as West Virginia is the cost. The least expensive of the studies that reported costs was $100 000.13 and in the most recent Canadian study, the cost eclipsed $1 million.12 When one considers the mounting evidence discussed subsequently that these studies may need to be delivered in a recurrent fashion for sustained benefit, the need for an alternative, less costly delivery mechanism becomes apparent. In our study, the cost of the materials made and distributed by the EMS agencies was $20 000 over 2 years in the one county that took part during Phase I. During Phase II, each of the 4 intervention counties was given $5000 for supplies. It must be emphasized that in addition to being much less expensive than the previous mass media campaigns, some of the supplies’ cost will cover future educational activities, because EMS agencies were encouraged to create supplies that could be reused in the future to meet the need for recurring education. Interestingly, our one county that had extremely impressive results used a traditionally expensive mass media outlet (a TV commercial sponsored by the hospital). However, in this case, the EMS personnel were able to partner with the hospital and were able to stay within their study budget ($5000).

We did conduct a sensitivity analysis of our results from Phase II excluding this one county with exceptional results to assess its impact on our overall findings. With regard to stroke risk factors, “lack of exercise” still increased between the intervention and control counties, and tested community stroke awareness programs for their ability to both increase public stroke knowledge and impact behavior in the form of earlier presentation for treatment.11–15 Although the specific methods of each particular program vary, one common thread fundamentally ties them together: the use of mass media such as newsprint, TV commercials, and radio broadcasts to deliver the message.

Delayed presentation to an emergency department for treatment of stroke remains the main reason why patients are not eligible to receive lifesaving thrombolytic therapy.3,4,21–23 A plethora of studies continue to demonstrate persistent gaps in the public’s knowledge of stroke signs, symptoms, and the importance of taking immediate action (calling 911) for suspected stroke.7–9,19,24–29

Table 2. Phase II Intervention Versus Control Counties Random-Digit Survey Results*

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Pre (n=578)</th>
<th>Post (n=604)</th>
<th>Post–Pre</th>
<th>Pre (n=593)</th>
<th>Post (n=600)</th>
<th>Post–Pre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress</td>
<td>18.20%</td>
<td>18.20%</td>
<td>0.00%</td>
<td>17.90%</td>
<td>13.20%</td>
<td>−4.70%†</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>55.00%</td>
<td>51.80%</td>
<td>−3.20%</td>
<td>48.90%</td>
<td>44.00%</td>
<td>−4.90%</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>16.80%</td>
<td>19.50%</td>
<td>+2.70%</td>
<td>16.40%</td>
<td>13.80%</td>
<td>−2.60%</td>
</tr>
<tr>
<td>Smoking</td>
<td>25.30%</td>
<td>17.50%</td>
<td>−7.80%†</td>
<td>25.60%</td>
<td>17.20%</td>
<td>−8.40%†</td>
</tr>
<tr>
<td>Diabetes</td>
<td>6.20%</td>
<td>5.00%</td>
<td>−1.20%</td>
<td>6.90%</td>
<td>6.80%</td>
<td>−0.10%</td>
</tr>
<tr>
<td>Overweight</td>
<td>16.40%</td>
<td>17.70%</td>
<td>+1.30%</td>
<td>18.50%</td>
<td>18.30%</td>
<td>−0.20%</td>
</tr>
<tr>
<td>Alcohol</td>
<td>4.20%</td>
<td>2.60%</td>
<td>−1.60%</td>
<td>3.90%</td>
<td>3.70%</td>
<td>−0.20%</td>
</tr>
<tr>
<td>Lack of exercise</td>
<td>9.50%</td>
<td>13.90%</td>
<td>+4.40%†</td>
<td>8.10%</td>
<td>6.80%</td>
<td>−1.30%</td>
</tr>
<tr>
<td>Age</td>
<td>2.40%</td>
<td>7.80%</td>
<td>+5.40%†</td>
<td>2.40%</td>
<td>1.80%</td>
<td>−0.60%</td>
</tr>
<tr>
<td>Family history</td>
<td>6.60%</td>
<td>8.40%</td>
<td>+1.80%</td>
<td>7.30%</td>
<td>4.30%</td>
<td>−3.00%†</td>
</tr>
<tr>
<td>At least one</td>
<td>82.50%</td>
<td>72.70%</td>
<td>−9.80%†</td>
<td>78.40%</td>
<td>71.80%</td>
<td>−6.60%†</td>
</tr>
</tbody>
</table>

Warning sign

| Dizziness           | 15.90%     | 23.30%      | +7.40%†  | 12.50%     | 21.20%      | +8.70%†  |
| Understanding       | 3.30%      | 3.80%       | +0.50%   | 0.70%      | 2.00%       | +1.30%   |
| Headache            | 15.60%     | 25.50%      | +9.90%†  | 14.80%     | 14.80%      | 0.00%    |
| Vision              | 9.00%      | 12.40%      | +3.40%   | 7.30%      | 13.00%      | +5.70%†  |
| Shortness of breath (fake)‡ | 4.50% | 3.30% | −1.20% | 2.70% | 3.50% | +0.80% |
| Speech              | 26.00%     | 33.60%      | +7.60%†  | 19.90%     | 16.70%      | −3.20%   |
| Weakness            | 11.80%     | 16.20%      | +4.40%†  | 11.50%     | 7.30%       | −4.20%†  |
| Numbness            | 34.80%     | 38.40%      | +3.60%   | 32.70%     | 30.30%      | −2.40%   |
| At least one        | 63.30%     | 68.20%      | +4.90%   | 57.50%     | 57.30%      | −0.20%   |

Response

| Call 911            | 77.50%     | 77.50%      | 0.00%    | 72.30%     | 73.00%      | +0.70%   |

*Percentages represent the proportion of respondents within each experimental group (intervention or control) that mentioned each stroke risk factor, warning sign, or mentioned calling 911 for stroke during the random digit telephone surveys. Pre indicates preintervention; Post, postintervention.
†P<0.05 by χ² test for the difference in proportions from preintervention to postintervention.
‡Shortness of breath represents a cardiac symptom measured to test the ability of respondents to distinguish between stroke and heart attack. In this case, a decrease in the intervention counties coupled with an increase in the control counties represents a positive impact from the intervention.
survey periods in the intervention counties, but this increase was no longer statistically significant (+1.5%). “Age” as a risk factor was still reported by significantly more residents exposed to the intervention in the postintervention period (+2.2%) even with the exclusion of this county. With regard to stroke warning signs, “speech” and “weakness” were no longer significantly increased postintervention when this county was excluded. “Headache” was still mentioned by significantly more individuals, and the proportion of individuals mentioning “numbness” approached significance \((P=0.08)\) with a +5.6% increase even with this county excluded. Clearly, this analysis points to the need for future research to test whether different EMS delivery mechanisms have a more efficacious impact.

Obviously, the greatest cost not factored into our model is personnel cost and time. No specific additional money was paid to the EMS personnel who participated in this study. The EMS personnel welcomed the opportunity to volunteer some of their time to deliver the educational materials, in part because many had been personally affected by the tragedy of untreated stroke. When one factors in study personnel and random-digit survey costs that were only needed for this pilot demonstration, then the total cost of both study phases over 2 years was $122 000. Because the goal of the interventions was to reach as many individuals as possible within the community, a cost per resident reached could be conservatively calculated by dividing the total cost of the study, including personnel costs, by the total number of residents residing in the counties where an intervention was present. There were 452 107 residents living within the counties where the EMS intervention took place, which yields a cost of 0.27 cents per person reached. When one excludes the number of individuals residing in these counties that were <18 years old (92 590), the cost per resident increases to 0.34 cents per person reached.

Of particular interest is the fact that there is growing evidence from these demonstrations that the educational message may need to be delivered in a recurrent, ongoing fashion to have lasting results.⁶ Our results from Phase I would directly support this notion. An examination of Figure 3 clearly shows a pattern of knowledge increase during the presence of the intervention followed by decline in the absence of the intervention in 2 of the 3 outcome measures during the 2-year study period. Of particular note is the fact that the declines in all 3 outcome measures observed at the 5-month long-term follow-up period after cessation of the community intervention in Year 2 were all statistically significant \((P<0.05)\). These findings also elucidate our decision to “pulse” the intervention in Year 2 of Phase I. We had actually planned to pulse the intervention in both study years, but an unanticipated funding delay precluded this approach during Year 1.

An examination of Figure 3 would suggest mixed results when comparing the “one-time,” passive intervention approach in Year 1 with the “pulsed,” active intervention approach in Year 2 with a greater intervention effect on warning signs from the one-time approach versus greater gains in the ability to name at least one risk factor and mention calling 911 from the pulsed approach. With regard to the latter, however, the increase in risk factor knowledge was not statistically significant (+7%; \(P=0.12\)). Perhaps this situation may be attributable, in part, to the fact that there has not been a comparable mnemonic for the various stroke risk factors (ie, FAST [Face Arm Speech Time to call 911] for stroke signs) that make them easier to remember and thus easier to print on a sign or poster with limited space. Therefore, one might surmise that EMS personnel had more time to discuss stroke risk factors with the public during their more active interactions, which contributed to these different outcome trends. However, future studies with a more rigorous design are needed to test this specific hypothesis.

The positive intervention impact observed on the proportion mentioning “call 911” in Year 2 must also be interpreted with caution given the significant increase in this proportion that occurred during the cessation period between Year 1 and Year 2. We cannot directly explain why the proportion of individuals surveyed that mentioned calling 911 for stroke declined (although not statistically significantly) during the first year of the study and then increased during the cessation period between Year 1 and Year 2, but this could indicate the presence of a historical threat to internal validity in the form of exposure to other stroke education messages. Interestingly, in one control county, a billboard was placed near a county hospital in May 2007 emphasizing the need to call 911 for stroke (the intervention month period for Phase II) that did not have an obvious impact on our results. To our knowledge, no other stroke education materials appeared in the program communities during the study period. This situation also highlights the reason for our addition of control counties during the Phase II expansion of our study.

With regard to the Phase II study results, although there were very encouraging patterns observed from an analysis of the mention of individual risk factors, we cannot fully explain the significant decrease in the proportion of residents in both intervention and control counties able to name at least one stroke risk factor. It could be due to a ceiling effect (ie, baseline proportions of this measure in the intervention and control counties were 83% and 78%, respectively), but may also be due to a trend toward EMS agencies emphasizing warning signs in their messages over risk factors (Figure 2). In general, we found that larger educational materials such as posters and the bus signs contained information on stroke signs and the need to call 911, whereas smaller materials such as newspaper ads, flyers, and brochures contained information on stroke risk factors. This bias may have explained better results with regard to knowledge of stroke signs and symptoms versus risk factors.

Similar to the findings in Phase I during Year 1, the greatest intervention effect in the expansion during Phase II was found in knowledge of stroke warning signs. It must be noted, however, that the increase did not meet our definition of a positive intervention effect in the sense that the 5% increase observed in the intervention counties did not cross our significance threshold but was very close \((P=0.08)\).

**Limitations and Future Directions**

Like with any study, there are some limitations to our study findings. Telephone surveys run the risk of obtaining a biased
sample if some individuals do not have telephones or if their phone numbers are unlisted. We used random-digit dialing to reduce bias from the latter source, but the former is a very real possibility in our rural setting. However, greater than 9 of 10 households in West Virginia have a telephone. The fact that the survey was conducted by different members of the study team may have also introduced bias. We did use a standardized script to counteract any variability stemming from this design consideration. Perhaps the most important limitation to the survey was the fact that we did not record demographic information on our participants, because we were most interested in the overall effect of our program on stroke knowledge. However, in hindsight, it would have been prudent to obtain demographic information to allow subgroup analyses to determine if there is a particular demographic category that is more efficaciously impacted by our novel EMS-driven approach, especially given the average age and education level imbalances between our intervention and control counties. Furthermore, a previous study by Pancioli et al19 found that stroke knowledge was significantly worse among the very elderly (>75 years old), which highlights the importance of gathering information on the impact of these community interventions within different demographic cohorts. Finally, it is possible that some individuals may not have been able to read the material within the community, because approximately one in 5 West Virginians are low-level readers.31 We did not specifically ensure that designed educational materials were no higher than the sixth grade level within our plan to test the hypothesis that EMS personnel know best the types of materials that would be received by the communities in which they work and live.

Our results are also subject to the threat of making a Type I error due to inflation of the familywise error rate stemming from multiple statistical comparisons. This situation is especially of concern for the results presented in Table 2, in which 20 statistical comparisons were made. We did not correct our statistical threshold for this threat given the exploratory, pilot nature of our study. However, if a Bonferroni correction to alpha based on the number of comparisons had been used, a threshold of 0.0025 (0.05 per 20 comparisons) would have needed to be crossed to reject the null hypothesis of no difference between the survey periods. Even with this corrected threshold, the risk factor of “age” and warning sign of “headache” both crossed this threshold (P<0.001). Furthermore, the warning sign of “speech” was very close to this threshold (P=0.004). The risk factor of “lack of exercise” and the warning sign of “weakness,” however, were above this corrected threshold (P=0.024 and P=0.029, respectively). Further work is needed to not only elucidate the impact of this approach in specific demographic groups, but to also elucidate the optimal method using the EMS approach for maximizing public knowledge of stroke risk factors and the need to call 911 at the first sign of stroke. Finally, these results represent our findings in a few racially and ethnically homogenous (95% white) counties in West Virginia. The absence of black and Hispanic individuals in our intervention settings is a noted limitation given the high risk that these groups have for stroke. Therefore, these results may not be generalizable (external validity) to other locales and settings, especially those with different racial and ethnic compositions.

Conclusions
Results of this novel pilot study suggest that the public’s knowledge of stroke signs and symptoms were increased using communitywide EMS-based programs. Given their relatively low cost in comparison to other mass media education programs, EMS-driven stroke education may be a valuable resource that is available in every community. Further studies are needed to confirm these results in other locales and to examine the best methods for increasing knowledge of stroke risk factors and calling 911 using the EMS approach. Finally, the impact of this novel EMS education approach on actual behavior in the form of earlier presentation for thrombolytic treatment needs to be studied and reported.

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None.

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