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Temporal Trends in Public Awareness of Stroke Warning Signs, Risk Factors, and Treatment

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Introduction

Stroke is the third leading cause of death in the United States and is a leading cause of major disability.[1, 2] There have been many improvements in stroke prevention strategies during the last 15 years, including a variety of new medications and surgical procedures for controlling stroke risk factors and preventing stroke.[3-8] In spite of this, the incidence of stroke during the

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1990s in the U.S. did not decrease,[9] and the prevalences of many stroke risk factors have been increasing, especially diabetes.[10] A key consideration to improve stroke prevention may be public awareness of stroke risk factors and changes in behavior toward controlling these chronic conditions. Little is known about the change over time in the public's perception of stroke risk factors.

Once an ischemic stroke occurs, the only FDA-approved medication available for acute treatment is recombinant tissue plasminogen activator (rt-PA). When given to appropriate patients, rt-PA significantly improves functional outcome.[11] Unfortunately, rt-PA is given to very few ischemic stroke patients, with U.S. national estimates ranging from 1.6% to 3%.[12-14] A previous study found that delay in seeking medical attention after stroke symptom onset is the most frequent reason for low rates of thrombolytic use for acute ischemic stroke.[15] Delays may be related to poor recognition of stroke symptoms or to lack of awareness that stroke treatments are time sensitive. We describe public knowledge of rt-PA as a treatment for ischemic stroke as well as changes over time in public knowledge of stroke warning signs and risk factors.

Methods

The Greater Cincinnati/Northern Kentucky region, which includes two southern Ohio counties and three contiguous Northern Kentucky counties that border the Ohio River, contains an essentially bi-racial population of 1.3 million. The residents of the study population are reasonably representative of the United States population with regard to median age, percentage of blacks, median household income, and percentage of population below the poverty level (Table 1). Only residents of the five study counties are considered for participation in the survey. Survey respondents were contacted by telephone in 1995, 2000, and 2005. Only blacks and whites were surveyed, because the population within the sampling frame has a low percentage (<2%) of other ethnic minorities. We used random-digit selection of telephone numbers and random respondent selection within a household. Details of this method have been previously described.[16, 17]

Since the aim of this survey was to document public knowledge of stroke within those at highest risk for a stroke or TIA event, we wanted to ensure that the demographic characteristics of the respondents approximated those of the ischemic stroke population. To achieve this, we created a demographic table that contained the required number of respondents in each of the individual categories defined by age, race, and sex, based on a long-standing population-based incidence of stroke study within the same population.[9] Once someone in the household was contacted by phone, questions were asked to determine whether a member of the household matched an unfilled demographic. If not, the call was terminated. To obtain an adequate number of respondents, the total number of calls placed ranged from 25,000 to 41,000 per study period, which includes calls with no answer, non-working numbers, and businesses (which were excluded). Cell phone numbers were not included in these surveys, as a recent report by the Pew Research center found that cell-phone-only users were "neither numerous enough nor different enough on the key dependent variables to produce a significant change in overall general population survey estimates."[ref?] In addition, cell-phone-only use is uncommon in the elderly (0.5-1.0%), which constitutes a large proportion of our target population in a stroke-related survey. Calls were placed at varying times of day and days of the week, including the weekend, to avoid bias towards those not working. In each study period, the same methodology was used for obtaining respondents to the survey questions. Separate cohorts of respondents were obtained for the three study periods.

The survey instrument consisted of 45 questions, divided into three sections. Respondents were asked questions designed to assess the prevalence of stroke risk factors, as it has been shown that a respondent's own medical history clearly impacts health knowledge. These questions were identical to questions used in the 3rd National Health and Nutrition Examination Survey.[18] Respondents were also asked questions regarding stroke warning signs, risk factors, and in 2005, specific questions regarding t-PA in an open-ended fashion (e.g., “What are the warning signs of stroke?”____________________). Respondents were asked to give three answers each for warning signs and risk factors.

The following stroke warning signs were considered correct individual responses:[19] the sudden onset of 1) numbness or weakness of the face, arm or leg, 2) confusion or trouble speaking or understanding speech, 3) trouble seeing in one or both eyes, 4) trouble walking, dizziness, or loss of balance or coordination, and 5) severe headache with no known cause. The following modifiable risk factors were considered correct responses:[3] hypertension, smoking, heart disease, diabetes, prior transient ischemic attack or ischemic stroke, heavy alcohol use, and hypercholesterolemia.

Chi-square was used for analysis of the categorical variables, gender, education, race, and the stroke risk factors (hypertension, diabetes, current smoking, heart disease, prior stroke or TIA, and high cholesterol) between years. Chi-square was also used for the initial assessment of the number of known risk factors and warning signs between years. Analysis of variance was used to look at the difference in mean age over the years. P-values for differences between individual years were corrected for multiple comparisons, using a Bonferroni correction. The Cochran-Armitage trend test was used to examine the overall comparisons over time for the categorical variables mentioned above. Multiple logistic regression analysis was used to assess changes over time for the stroke risk factors, adjusting for education. This enabled us to compare the overall change over time and individual differences between successive years. Multiple logistic regression was also used for assessing factors potentially associated with rt-PA knowledge. The initial model included the demographic characteristics age, gender, education and race, plus those risk factors bivariately associated with rt-PA knowledge at $p<0.25$, specifically current smoking, prior stroke or TIA, and high cholesterol, a backward elimination approach was employed to get the final model.

Results

Over the 10-year study period, 6,209 surveys were completed. In 1995, 17,634 households were contacted, which yielded 2,642 persons who were demographically eligible to participate, of which 1,880 (71.2%) agreed to participate, 397 (15.0%) refused, and 365 (13.8%) did not complete the interview due to language barriers, illness, or unavailability despite multiple callbacks during the study period. In 2000, 25,056 households yielded 3,151 eligibles, of which 2,173 (69.0%) agreed to participate, 152 (4.8%) refused, and 826 (26.2%) were unavailable. In 2005, 41,836 households yielded 3,228 eligibles, of which 2,156 (66.8%) agreed to participate, 207 (6.4%) refused, and 865 (26.8%) were unavailable. The decrease in the rate of participation over time was statistically significant ($p=.0003$).

The demographics of the respondents, shown in Table 2, were similar for all three study periods with the exception of education, which significantly increased over time: 41% reported education above the high-school level in 1995 vs. 50% in 2000, $p<0.001$, and 54% in 2005, $p=0.01$ compared with 2000. This is consistent with information from the U.S. Census website (www.census.org), which shows that the percentage of the overall population of the 5-county study area with a high school diploma increased from 75% in 1990 to 83% in 2000.

The prevalence of disease conferring cerebrovascular risk within the population is presented in Table 2. We found an increasing prevalence of the diagnosis of high cholesterol over time, while the prevalence of heart disease, smoking, and prior stroke were stable. The temporal trends in the prevalence of diabetes and hypertension, however, varied over time: history of diabetes significantly increased between 1995 and 2000, but not between 2000 and 2005, while the prevalence of hypertension was stable between 1995 and 2000 but significantly increased between 2000 and 2005.

The percentage of the target population who knew at least one risk factor improved from 59% in 1995 to 71% in 2000 (p<0.0010, Table 3), and knowledge of at least one warning sign improved from 48% to 68%, p<0.001. However, between 2000 and 2005 there was little improvement. This lack of improvement was evident in knowledge of at least one risk factor (71% for both study periods), knowledge of at least one warning sign (68% for both study periods), and knowledge of 3 risk factors (4% in 2000, 5% in 2005). However, there was a significant improvement in knowledge of 3 warning signs (5% in 1995 vs. 12% in 2000 vs. 16% in 2005, p<0.0001 for overall trend, p=0.0004 comparing 2000 with 2005). This improvement was still evident after correcting for baseline differences in education between study periods (data not shown).

In 2005, when asked the question: "Suppose you were having a stroke. Do you know of any medication your doctor could give you into the vein to increase your chance of recovering from a stroke?" only 3.6% of those surveyed were able to independently name rt-PA or an approximation of rt-PA (such as "TPC", or "TMA" or "clot buster"). Respondents who were able to name rt-PA (n=79), when compared with those who were not, were more likely to have higher education, were more likely to be of white race (Table 2), and were slightly younger (mean age of those aware 61.0±17.1 years old, compared with 62.4±14.1 years old for those unaware, p=0.03). Those aware of rt-PA were also more knowledgeable about stroke risk factors and warning signs (p<0.0001 for both). The most common other unaided responses to the acute treatment question were aspirin (5.6%) and warfarin (1.2%).

Logistic regression analysis of demographic factors associated with knowledge of rt-PA found that black race was still associated with poorer knowledge of rt-PA compared to whites, after correcting for education, age, and gender (OR 0.21, 95% CI 0.08-0.53). Education was also independently associated (for those <12th grade education, OR 0.39, 95% CI 0.23-0.66), but age and gender were not.

If respondents indicated that they had heard of rt-PA, we then asked: "How soon does TPA need to be given after a stroke begins for it to be most effective?", in an open-ended manner. "Less than three hours" was stated by only 7 (9%) of those familiar with rt-PA, although an additional 55 (70%) of responses indicated urgency (including "immediately, within seconds, couple/few hours/within hours and as soon as possible/the sooner the better).

Discussion

We found that the public knowledge of stroke risk factors did not substantially improve between 2000 and 2005. This finding was the opposite of what would be expected, given the mild improvement in educational level among the survey respondents over time and the previous study period's improvement in knowledge between 1995 and 2000. Knowledge of stroke warning signs did slightly improve; those able to name 3 warning signs improved from 5% in 1995 to 16% in 2005. However, there was no improvement in the ability of the public to name at least one warning sign.

Within this survey, we were also able to track prevalence of stroke risk factors within the general population. We found that the rate of hypertension, diabetes, and hypercholesterolemia increased during the 10 year period, and rates of smoking, heart disease, and prior stroke were stable. This is consistent with other large surveys of disease prevalence.[10, 20-24] Despite the increased prevalence of stroke risk factors in successive study periods, improvement in knowledge of medical conditions that are risk factors for stroke was not seen in the successive cohort of respondents. A key component of many theories of social learning is the importance of patients' understanding of their own personal risks.[25-27] If patients do not understand that these conditions place them at higher risk, they are less likely to pay attention to awareness messages, as they will seem irrelevant.

Understanding that there are potential treatments that might help reverse the problem is also a well-known key determinant of patient behavior.[28, 29] In 2005, we added questions about knowledge of rt-PA, and we found that the vast majority of the public were unaware of rt-PA as a potential treatment. As expected, educational level was associated with knowledge level, and those knowledgeable about rt-PA were also more knowledgeable about stroke warning signs and risk factors. Also, those who were aware of rt-PA were likely to be aware that time is of the essence, although most were not able to state a specific time window. Blacks were far less likely to be aware of rt-PA, even after controlling for education. This is especially tragic, as the risk of stroke is 2-4 times higher in blacks than in whites. Public messages regarding stroke should likely be targeted for minority populations.

The lack of improvement in public knowledge of warning signs and risk factors for stroke among our population was especially surprising, considering that the multi-disciplinary Greater Cincinnati/Northern Kentucky Stroke Team has been actively involved with educating the community about stroke since 1988, including programs for both medical professionals and the lay public. In fact, new messages, efforts, and ad campaigns have increased during the later part of the study periods, when knowledge was essentially static. Within a population of 1.3 million, with widespread access to public media and internet, it is not possible to track how many stroke educational messages were delivered to which people within the community, nor how many other health messages for other disease states competed for their attention within the same time frame. One potential explanation for the lack of more recent improvement is that there may be a theoretical limit to how much knowledge the public can absorb from such efforts. A more likely explanation is that the national and local campaigns that have been implemented have not been targeted appropriately to the audience, nor tested for efficacy before implementation. Clearly, scientific study of the effectiveness of stroke educational efforts at individual and aggregate levels is warranted.

Limitations of our analysis include the study methodology of telephone-based surveys. Random-digit-dialing phone surveys have been criticized recently as being “out-of-touch” with the ubiquity of cell phones in communities. Recent studies, however, have found that very few households have *only* cell phones; most homes still have “land lines” in addition to cell phones.[30-32] This is especially true among the elderly, an important demographic for this survey: a recent study from the National Health Interview Survey estimates 2.3% of the elderly have only cell-phone lines[33]. All medical history disease prevalence information was determined by self-report, which is limited by patients' knowledge of their own medical history. While this is a standard limitation of phone surveys, it is a reasonable way to describe disease prevalence on a large scale among the general public.

Public awareness messages in the future should focus on the availability of urgent treatments, in addition to stroke warning signs and risk factors. Some of these messages should be specifically targeted to the black population, who have a higher incidence of stroke[9, 34] and a significant lack of awareness of rt-PA compared with the white population. Increased knowledge of acute stroke treatments may motivate the public to translate their knowledge into action and present to medical attention more quickly. This may be the highest yield approach to increasing rates of treatment of ischemic stroke with t-PA.

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Table 1

Comparison of Demographics between the Greater Cincinnati/Northern Kentucky Region and the United States, based on U.S. Census 2000

	Greater Cincinnati population	United States population
Size	1,349,351	281.4 mil
Median Age (yrs)	35	35
Black (%)	15.4%	12.3%
White (%)	81.5%	75.1%
Median household income	$43,107	$41,433
Below poverty (%)	10.1%	12.5%
High School Graduate (%)	82.6%	81.6%

Table 2

Comparison of Demographics and Stroke Risk Factor Prevalences Between Survey Years, Greater Cincinnati/Northern Kentucky Population

	1995 n=1,880	2000 n=2,173	2005 n=2,156	Trend over time p
Demographics				
Age in years (SD)	63 (16.0)	61 (17.3)	62 (17.4)	0.10
Women	1,121 (60%)	1,334 (61%)	1,328 (62%)	0.38
Education >12 yr	765 (41%)*	1,092 (50%)	1,164 (54%)^	<0.0001
Black	507 (27%)	554 (26%)	529 (25%)	0.21
Stroke Risk Factor Prevalence				
Hypertension	818 (44%)	983 (45%)	1063(49%)^	0.0007
Diabetes	255 (14%)	353 (16%)*	369 (17%)	0.006
Current Smoker	402 (21%)	433 (20%)	432 (20%)	0.45
Heart Disease	185 (10%)	207 (10%)	192 (9%)	0.58
Prior Stroke/TIA	129 (7%)	156 (7%)	178 (8%)	0.20
High Cholesterol	607 (32%)	822 (38%)*	936 (43%)^	<0.0001

* p <0.05 comparing 1995 to 2000 after correction for multiple comparisons

^ p<0.05 comparing 2000 to 2005 after correction for multiple comparisons

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Table 3

Comparison of Knowledge of Stroke Warning Signs and Risk Factors between Survey Years, Greater Cincinnati/Northern Kentucky Population

	1995 N=1880	2000 N=2173	2005 N=2156
Number of Correct Risk Factors Known			
0	606 (32.2%)	620 (28.5%)	624 (28.9%)
1	827 (44.0%)	899 (41.4%)	829 (38.4%)
2	398 (21.2%)	571 (26.3%)	600 (27.8%)
3	49 (2.6%)	83 (3.8%)	103 (4.8%)
Number of Correct Warning Signs Known			
0	845 (45.0%)	689 (31.7%)	689 (32.0%)
1	612 (32.6%)	606 (27.9%)	575 (26.7%)
2	321 (17.1%)	618 (28.4%)	553 (25.6%)
3	102 (5.4%)	260 (12.0%)	339 (15.7%)

Table 4
Logistic Regression Analysis of Predictors of Knowledge Regarding Rt-PA, 2005 Study Period Only

	Initial Model		Final Model	
Variable	**Odds Ratio for Knowledge of Rt-PA* (95% CI)**	**p-value**	**Odds Ratio for Knowledge of Rt-PA* (95% CI)**	**p-value**
Black	0.216 (0.086, 0.542)	0.001	0.211 (0.085, 0.527)	0.0008
Male	0.653 (0.400, 1.066)	0.09		
Education ≤12th grade	0.410 (0.242, 0.696)	0.001	0.436 (0.263, 0.725)	0.0014
Increasing Age (per decade)	0.991 (0.855, 1.155)	0.91		
Current smoker	0.520 (0.244, 1.106)	0.09		
Prior stroke or TIA	1.853 (0.911, 3.773)	0.09		
High cholesterol	1.460 (0.911, 2.340)	0.12		

*Unaided response of "t-PA", an approximation of t-PA, or "clotbuster" when asked: "Suppose you were having a stroke. Do you know of any medication your doctor could give you into the vein to increase your chance of recovering from a stroke?"