Knowledge of risk factors and warning signs of stroke

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Abstract: In this review, we have summarized the findings of fifteen studies of knowledge of stroke warning signs and risk factors in both high- and low-risk populations. In general, there appears to be low levels of knowledge of both risk factors and stroke warning signs among the communities studied. Using free recall, between 20% and 30% of respondents could not name a single risk factor, and between 10% and 60% could not name a single warning sign of stroke. Providing survey respondents with a list of potential warning signs substantially improved the identification of warning signs. Respondents in older age groups and having lower levels of educational attainment tended to have less knowledge of risk factors and warning signs of stroke than those in younger age groups and those with more education. Public campaigns to improve stroke knowledge are needed, particularly in the older age groups where the risk of stroke is greater.

Keywords: stroke, awareness, risk factors, knowledge, survey

Introduction

Stroke is the second most common cause of death worldwide and a significant cause of chronic disability (Murray and Lopez 1997). In a study conducted in Australia, it has been reported that within 12 months of a stroke, approximately 37% will die and 10% will experience a recurrent stroke (Thrift et al 2000; Dewey et al 2001). Of those who survive their stroke, approximately 51% are disabled in some activity of daily living, and 50% exhibit either cognitive impairment or dementia (Sturm et al 2002; Srikanth et al 2004). This represents a considerable burden to our community.

Despite the decline in mortality from stroke over recent years (Waters and Bennet 1995), there is a looming epidemic of stroke. The increased proportion of the population in the older age groups that is predicted to occur in future years will contribute to this epidemic because of the strong association between age and stroke incidence. Using age- and sex-specific stroke attack rates obtained in a recent population-based study in Melbourne, Australia, and applying them to the Australian population (Thrift et al 2000), it is estimated that approximately 42 200 strokes would have occurred during 1997. If we apply these same attack rates to the projected population of Australia 20 years later (2017) (Australian Bureau of Statistics 2003), it is estimated that approximately 67 500 strokes will occur in that year. This resulting rise in the number of stroke cases in the elderly will significantly increase the burden of this disease and is also likely to overwhelm the resources currently available for stroke care.

There are two main ways in which we can reduce the burden of this disease. First, we can improve outcome after stroke by providing patients with proven therapies. These therapies include the use of intravenous tissue plasminogen activator (tPA) within 3 hours of ischemic stroke onset (Hacke et al 1999; Wardlaw et al 2003),

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aspirin within 48 hours (Chen et al 2000), and treatment in a stroke care unit (Stroke Unit Trialists' Collaboration 2004). For the first of these therapies, patients need to attend hospital within approximately 2 hours of stroke onset. Currently, only about 1%–2% of patients receive this treatment (Birbeck et al 2004). The most common reasons that patients are not treated with tPA are that they do not attend hospital within the treatment time window (Kleindorfer et al 2004), that there are insufficient trained staff, and that patients are ineligible for treatment. Although the proportion receiving therapy could be improved by increasing the number of centers in which this therapy could be administered, reducing the delay to hospitalization would also considerably improve access to this therapy.

The second way in which we can reduce the burden of stroke is to reduce the number of people experiencing a stroke. This could be undertaken by implementing good primary and secondary prevention measures at an individual and population level. The individual (or high-risk) approach involves identifying high-risk people and altering their risk factor profile by either reducing risky behaviors or introducing treatments. The population (or mass) approach involves either mass screening or education campaigns to reduce risky behaviors at the population level.

To reduce delays to hospitalization following stroke and to improve risk factor profiles of the population requires knowledge about stroke and its risk factors. In view of the importance of understanding the level of community awareness of stroke, we undertook a review of the literature in this area.

The aim of this review is to compile the findings of a number of groups that have investigated levels of knowledge of stroke signs, symptoms, and risk factors. Drawing these results together will provide readers with some insight into different communities' understanding of stroke, and thereby highlight areas where improvements can be made with targeted campaigns.

Table 1 provides a summary of the publications discussed in this review. As can be seen from this table, there is a mix of both open-ended and closed-ended types of approaches to studying stroke knowledge. Although open-ended survey questions provide the researcher with the most "open and honest" assessment of the respondent's knowledge, the results are often difficult to compile and analyze. For the results of an open-ended survey to be reported, it is often necessary for the researcher to make a decision as to what the intention of a subject's response was and to group responses into similar categories. Because this coding

process involves judgment decisions, it is always possible that the results may be biased by this decision process. Rowe et al (2001) attempted to address this issue by coding responses using two individuals, and where a discrepancy was found, a third party was used to resolve the issue.

When knowledge of stroke symptoms is assessed using closed-ended questions, a different type of response is evoked, as the act of asking the question provides the respondent with some indication of what the answer could be. In the two studies in this review where respondents are asked to identify stroke symptoms from a provided list (Yoon et al 2001a; Greenlund et al 2003), there is a tendency for all *suggested* symptoms of stroke (including those that are definitely *not* stroke symptoms) to be identified as *actual* symptoms – this may be a reflection of some of the inherent difficulties in using closed-ended questions. Positive responses identifying a particular stroke symptom appear to be more prevalent when using closed-ended rather than open-ended questions. For example, Rowe et al (2001) utilized both approaches: for closed-ended questions, between 77% and 95% of respondents correctly identified different symptoms of stroke, while for open-ended questions, these values were between 7% and 24%.

In seven of the studies, telephone contact was used as the method of survey administration. Although this method is definitely more efficient and cost-effective than face-to-face interviews, there is a small degree of selection bias whereby people without a telephone are excluded from the study, although this effect is likely to be small as these studies were all performed in areas where telephone access would be very high. For example, Pancioli et al (1998) noted that 96% of all households in their survey area had reported having a telephone service. In one study, nonrespondents included a group that were not interviewed due to a communication barrier (Rowe et al 2001). It is possible that this process may have reduced the generalizability of results, as people from non-English-speaking backgrounds and those with speech difficulties may have been excluded from the study group.

Sample size is an important issue in any study, particularly in population-based research, where large numbers of respondents are needed to provide adequate power. The largest study among the group reviewed here is that of Greenlund et al (2003), in which more than 61 000 individuals were surveyed across the USA. Although this study is extremely large, the response rate was relatively low – a median value of 53% was stated. Three of the studies in this review were conducted using very small (<200)

samples (Kothari et al 1997; Hux et al 2000; Weltermann et al 2000), and the results of these studies would therefore need to be interpreted with caution.

Ideally, response rates for community-based surveys should be 80% or more. When responses fall below this level, it is possible that those subjects who did *not* respond to the survey may have been substantially different from those who did, thereby adversely affecting the result. Only two of the studies reviewed here had response rates greater than 80% (Kothari et al 1997; Weltermann et al 2000), while the remainder varied from 70% to as low as 45%.

Knowledge of warning signs

In the majority of publications in this review, the authors have grouped responses to questions about stroke knowledge into categories that closely resemble the five stroke warning

Table 1 Summary of all studies

Authors	Sample	Interview method	Number of respondents	Response rate	Mean age	Question type	Assessment type	Multivariate analysis
Low risk groups								
Cincinnati USA (Pancioli et al 1998)	Community	Telephone	1880	71.2%	63	Open ended	SS, RF	Yes
Cincinnati USA (Schneider et al 2003)	Community	Telephone	2173	69.0%	61	Open ended	SS, RF	Yes
Newcastle Australia (Yoon et al 2001a, 2001b)	Urban community	Telephone	822	62.0%	49	Open and closed ended	SS, RF, prevention	Yes
Michigan USA (Reeves et al 2002)	Community	Telephone	2512	45.4%	Not stated Estimate = 45	Open ended	SS, RF	Yes
Northern Ireland (Parahoo et al 2003)	Community	Mail-out	892	46.0%	Not stated Estimate = 47	Open and closed ended	SS, RF	No
Devon UK (Carroll et al 2004)	Community	Face-to-face	40	Not stated	71	Open ended	SS, RF	No
Georgia USA (Rowe et al 2001)	Community	Telephone	602	47.8%	41 (median)	Open and closed ended	SS, RF, prevention	Yes for SS, No for RF
USA (Mosca et al 2000)	Community	Telephone	867	35.8%	Not stated Estimate = 48	Open ended	Health problem identification	No
Northrhine-Westfalian region, Germany (Weltermann et al 2000)	Stroke support group members	Self-administered	133	96.2%	65	Open ended	SS, RF	Yes
Lincoln, USA (Hux et al 2000)	Community (shopping mall)	Face-to-face	190	Not stated	Not stated Estimate = 43	Open and closed ended	SS, RF	No
USA (Greenlund et al 2003)	Community	Telephone	61 019	53.3%	Not stated Estimate = 47	Closed ended	SS	Yes
High risk groups								
Cincinnati USA (Kothari et al 1997)	ED diagnosis of stroke or TIA	Face-to-face	163	93.7%	65	Open ended	SS, RF	No
Devon UK (Carroll et al 2004)	People with recent stroke and TIA	Face-to-face	40	Not stated	71	Open ended	SS, RF	No
USA (Samsa et al 1997)	Past history of stroke or TIA, or people with risk factors for stroke	Telephone (74%) and face-to-face (26%)	1253	55.8%	Not stated Estimate = 64	Open ended	Self-risk of stroke	Yes
Cardiff UK (Gupta and Thomas 2002)	Hospital clinic – people with risk factors for stroke	Face-to-face	410	Not stated	78	Open and closed ended	SS, RF	No

Abbreviations: TIA, transient ischemic attack; ED, emergency department; SS, signs and symptoms; RF, risk factor.
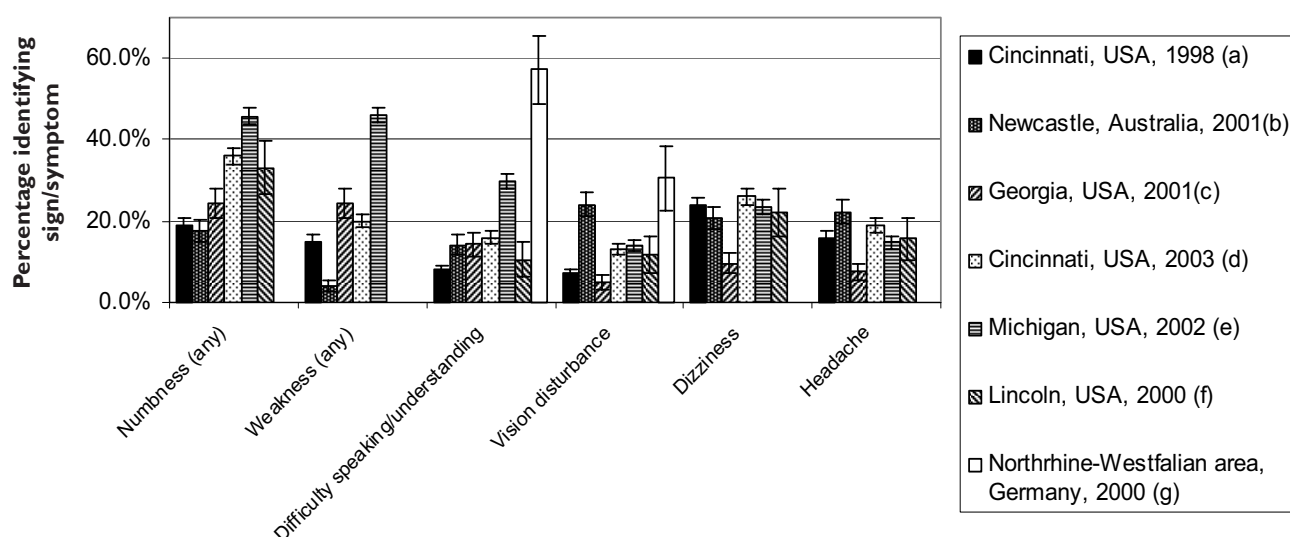
Figure 1 Results of open-ended studies of knowledge of stroke warning signs. (a) Pancioli et al 1998, (b) Yoon et al 2001b, (c) Rowe et al 2001, (d) Schneider et al 2003, (e) Reeves et al 2002, (f) Hux et al 2000, (g) Weltermann et al 2000.

signs established by the (American) National Institute of Neurological Disorders and Stroke (NINDS 2005):

- numbness or weakness in the face, arms, or legs (especially on one side of the body);
- confusion, difficulty speaking or understanding speech;
- vision disturbances in one or both eyes;
- dizziness, trouble walking, loss of balance or coordination;
- severe headache with no known cause.

The symptoms listed above are almost identical to those provided by Australia's National Stroke Foundation (NSF 2005), which includes a sixth sign, "difficulty swallowing".

To provide a brief summary of the findings of the studies where knowledge of stroke warning signs was reported, two figures of results have been constructed using the five common symptoms and signs of stroke, with data sorted into open- and closed-ended study types (Figures 1 and 2, respectively). Only those studies where the results can been grouped into these five signs have been displayed in the figure – any data regarding other signs or symptoms have been omitted.

The most immediately obvious finding of the comparison between studies of stroke knowledge is the difference in responses obtained using open- and closed-ended
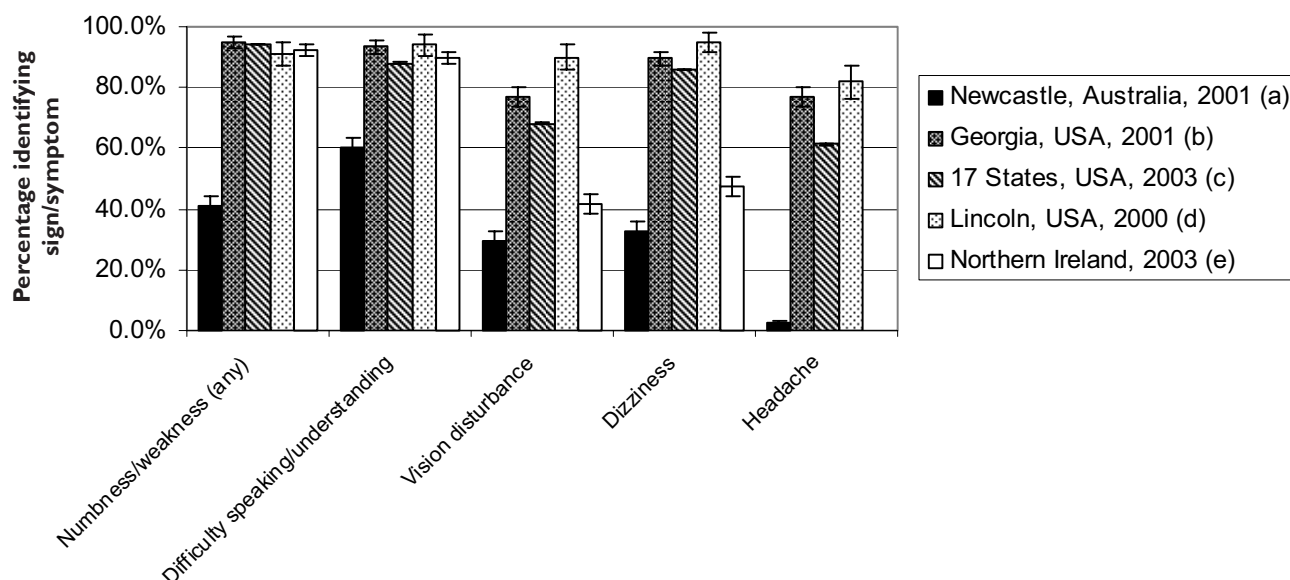

Figure 2 Results of closed-ended studies of knowledge of stroke warning signs. (a) Yoon et al 2001a, (b) Rowe et al 2001, (c) Greenlund et al 2003, (d) Hux et al 2000, (e) Parahoo et al 2003.
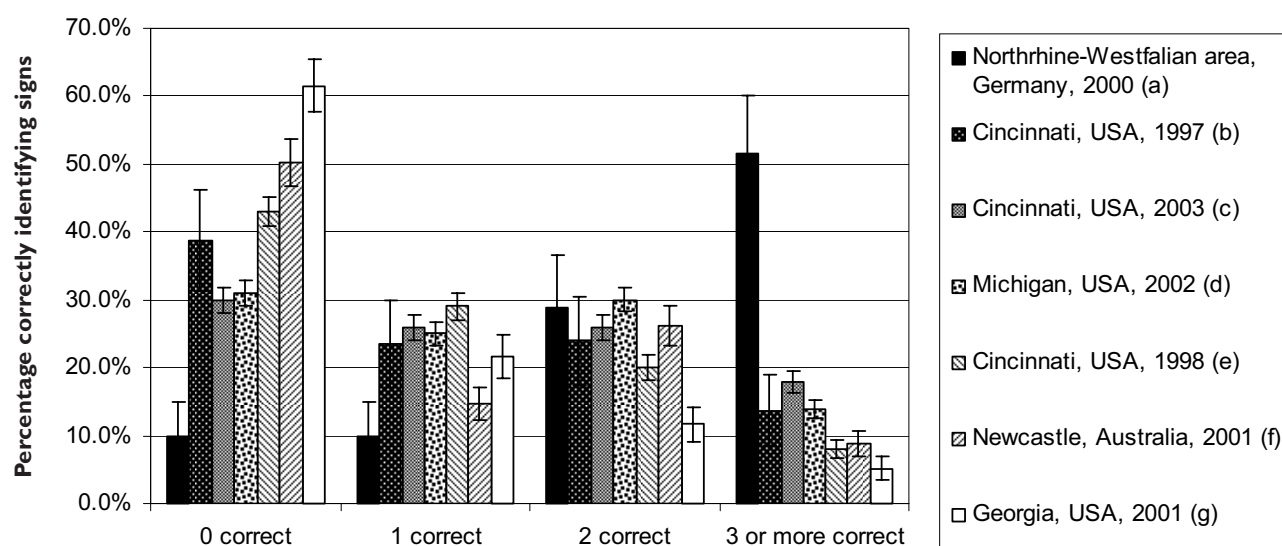
Figure 3 Number of stroke warning signs correctly identified using open-ended questions. (a) Weltermann et al 2000, (b) Kothari et al 1997, (c) Schneider et al 2003, (d) Reeves et al 2002, (e) Pancioli et al 1998, (f) Yoon et al 2001b, (g) Rowe et al 2001.

questionnaires. It appears that survey respondents are more likely to identify a particular stroke symptom when they are provided with a list of potential symptoms, as positive identification of various stroke symptoms was almost twice as high in the studies utilizing closed-ended questions (Figures 1 and 2). As mentioned previously, closed-ended type studies may provide the respondent with some prompt as to what the correct answer should be, and may therefore be more likely to elicit positive responses when compared with open-ended methods.

Addition of an incorrect symptom or sign to a list of possible symptoms can give the reader some indication of the respondent's tendency to provide positive responses to all proffered symptoms when utilizing closed-ended questions. Greenlund et al (2003) added "chest pain" to the list of possible symptoms of stroke, and 37.8% of respondents incorrectly identified this as a warning sign for stroke. However, this particular symptom may not be the best test of this behavior, as the authors of many open-ended studies in this review have found that symptoms and signs for heart attack are often confused with those for stroke (Pancioli et al 1998; Hux et al 2000; Yoon et al 2001b; Reeves et al 2002; Schneider et al 2003).

The number of established warning signs identified by individual respondents using open-ended questions has been summarized in Figure 3. Weltermann et al (2000), who used stroke support group members as subjects, had the highest levels of knowledge of stroke warning signs. This result is not surprising, as this group of individuals have a confirmed history of being exposed to the condition in question and

would be expected to be more aware of stroke signs and symptoms than the general public. The results shown in Figure 3 highlight the lack of knowledge of stroke warning signs among the general public: the proportion of individuals unable to name a single warning sign of stroke varied from slightly less than 30% up to 60%.

Regression analyses

Nine of the studies of stroke warning signs included the results of regression analysis of factors associated with increased knowledge of stroke warning signs and symptoms (Table 2). The common factors used in the regression analyses were basic demographic data: age, sex, education, and income level. In addition to this, other established stroke risk factors such as history of stroke, hypertension, and smoking were often included.

Younger age was found to be a significant predictor of improved knowledge of stroke warning signs in seven of the nine studies that included a regression analysis, although the very young (18–34) age groups also had a tendency toward lower stroke knowledge in some studies. In three of the studies (Reeves et al 2002; Greenlund et al 2003; Schneider et al 2003), knowledge was lower in *both* older and younger age brackets, with middle-aged people having the greatest knowledge of stroke warning signs. These results provide some evidence that those most at risk of stroke (older people) are the group with the least knowledge of stroke symptoms. Therefore, this age group could be the focus of targeted awareness campaigns.

Table 2 Results of multivariate regression analyses for predictors of increased knowledge of stroke warning signs

Authors	Question type	Predictors of increased knowledge of stroke warning signs/symptoms						
		Younger age	Female sex	Higher education level	Higher income level	History of stroke	History of hyper-tension	Race (white)
Cincinnati, USA (Pancioli et al 1998)	Open	✓	✓	✓	-	✓	✓	✗
Cincinnati, USA (Kothari et al 1997)	Open	✓	✗	✗	✗	-	-	✗
Newcastle, Australia (Yoon et al 2001b)	Open	✓	✗	✓	✓	✗	✗	-
Georgia, USA (Rowe et al 2001)[a]	Open	✓	✗	✓	✗	✓	-	✗
Cincinnati, USA (Schneider et al 2003)[b]	Open	✓	✓	✓	-	-	✓	✓
Michigan USA (Reeves et al 2002)[c]	Open	✗	✓	✓	✓	-	✓	✓
Northrhine-Westfalian area, Germany (Weltermann et al 2000)	Open	✓	✗	-	-	-	-	-
Newcastle, Australia (Yoon et al 2001a)	Closed	✗	✗	✓	✗	✗	✗	-
17 States, USA (Greenlund et al 2003)[d]	Closed	✓	✗	✓	✗	✗	-	✓

✓ = significant predictor of increased knowledge in multivariate analysis.
✗ = nonsignificant predictor of increased knowledge in multivariate analysis.
- = factor not used in multivariate analysis.
[a] Although the study included both open and closed questions, the regression analysis was only performed on the open-ended questions.
[b] Respondents with age > 35 and < 75 had increased knowledge of warning signs.
[c] Stroke knowledge was greater in those > 35 and lower in those aged 18–24.
[d] The effect of age was for "middle-aged persons"; ie, this group had greater knowledge of stroke symptoms than all others.

An individual's level of education is likely to have some influence on knowledge of stroke warning signs, and this was included as a potential predictor of stroke warning sign knowledge in eight of the nine studies that included multivariate regression analysis. Only Kothari et al (1997) reported that there was no significant influence of education level on an individual's stroke knowledge (see Table 2). Similar to age, higher education levels appear to have a positive influence on stroke knowledge. Rowe et al (2001) noted that there was a dose-response relationship between education and knowledge of stroke warning signs, with higher levels of education being associated with increased stroke knowledge.

There appears to be little difference in knowledge of stroke warning signs between males and females. Pancioli et al (1998), Reeves et al (2002), and Schneider et al (2003) all reported greater knowledge of stroke warning signs among females, while no effect of gender was reported in the remaining studies (Table 2). Because of this lack of consistency between the findings of different studies, it is unclear whether or not there is a gender difference in knowledge of stroke warning signs.

Because of the well established differences in stroke incidence between different racial groups, "race" has been included in the regression analysis for knowledge of stroke warning signs in the studies conducted in the USA. There is conflicting evidence for racial differences in knowledge of stroke warning signs. Three studies (Kothari et al 1997; Pancioli et al 1998; Rowe et al 2001) reported no independent effect of race on knowledge of stroke warning signs, whereas others (Reeves et al 2002; Greenlund et al 2003; Schneider et al 2003) found that blacks had less knowledge of these signs and symptoms. These results are complicated by the fact that income level was not included in the regression analyses by some investigators, which may have influenced the findings. It is important to control for this factor because of the potential interaction between race and income.

A history of stroke has also been included as a factor in the regression analysis of predictors of knowledge of stroke warning signs. Both Pancioli et al (1998) and Rowe et al (2001) found that history of stroke was a significant independent predictor of stroke knowledge, although each defined history of stroke differently. Pancioli et al (1998)

used history of stroke or transient ischemic attack (TIA) of the respondent, while Rowe et al (2001) used both a previous history of stroke of the respondent and family history of stroke. Although Rowe and co-workers used both an individual's past history of stroke and family history of stroke in the analysis, only the latter was a significant independent predictor of knowledge of stroke warning signs. In contrast to the findings of Pancioli and colleagues, Yoon et al (2001a, 2001b) found that history of stroke was not an independent predictor of increased knowledge of warning signs.

The majority of evidence presented here indicates relatively low levels of knowledge of stroke warning signs among members of the general public. To improve this situation, it is necessary to determine the sources of information regarding stroke. Among the studies reviewed here, one of the more frequently cited sources of information was friends and family members who had suffered a stroke. Between 20% and 70% of respondents in five separate studies (Pancioli et al 1998; Hux et al 2000; Yoon et al 2001b; Parahoo et al 2003; Schneider et al 2003) cited these people as sources of stroke knowledge. Mass media also appears to be an effective source of information, with 20%–30% of respondents noting newspapers, magazines, and television as their source of information regarding stroke. Less frequently, doctors and hospital personnel were cited as sources of stroke information, being cited by only 13%–20% of respondents in four studies (Pancioli et al 1998; Hux et al 2000; Yoon et al 2001b; Schneider et al 2003). These findings are important for organizations and individuals interested in improving stroke knowledge among the general public, as it would appear that dissemination of information through health professionals is less effective than mass media and peer networks.

Several authors have noted that many respondents appear to have some difficulty in making the distinction between stroke and heart attack. As mentioned previously, this distinction becomes acutely obvious when comparing open- and closed-ended studies of stroke knowledge. While Rowe et al (2001) found very high levels of recognition (between 76% and 95%) when respondents were read a list of potential stroke warning signs, there was also a strong tendency for signs of heart attack to be identified as stroke symptoms. In this study, 58% of respondents identified "chest pain" as a stroke warning sign. Reeves et al (2002) noted the confusion between stroke and heart attack in the pilot phase of their study and altered the survey procedure to ensure that respondents were made aware of the fact that stroke affects

the blood vessels supplying the brain rather than the heart. Despite these alterations to the survey instrument, they still reported that nearly 10% of respondents identified "pain in chest or arm" as a stroke warning sign. In contrast to these findings, Yoon et al (2001a) used a closed-ended survey and found less than 2% of respondents identified "chest pain, chest tightness or murmur" as a symptom of stroke. Surprisingly, in a second study by the same group, where open-ended questions were used, nearly 10% of respondents identified "chest pain or chest tightness" as a warning sign. Even though these levels are less than reported previously, this confusion between stroke and heart attack still remains.

In addition to the warning signs of stroke, there have been several attempts to determine community knowledge of the mechanism of stroke. Hux et al (2000) simply asked respondents "What is a stroke?" and compiled the results. In this study, 36.9% of respondents correctly described stroke as a disruption of blood supply to the brain, while an additional 25.5% gave partially correct responses. Partially correct responses were those where respondents mentioned that stroke affects the brain, or a disruption of blood supply, but not both. When asked to describe a stroke, 60.3% of those surveyed by Parahoo et al (2003) correctly described stroke as a "blood clot in the brain", while an additional 14.7% of respondents described stroke as paralysis.

In a study of patients admitted to an emergency department with a diagnosis of stroke, Kothari et al (1997) asked patients what part of the body is injured during a stroke. They reported that 49% of subjects realized that stroke was "due to an injury to the brain", which is similar to the findings of Weltermann et al (2000), using members of a stroke support group where 52.4% of respondents mentioned the brain or head. It is somewhat surprising that stroke knowledge among this group was relatively low, as the respondent group was 69.8% stroke patients and 27.8% family members. Better in-hospital and outpatient education could greatly improve the levels of knowledge among this at-risk population.

Knowledge of risk factors for stroke

Analysis of knowledge of risk factors for stroke has occurred in a number of different groups, including community groups, people at high risk of stroke or TIA, and those who have recently had a stroke or TIA (Table 1). In a community-based study, Pancioli et al (1998) reported that 68% of 1880 respondents to a telephone survey of people asked to
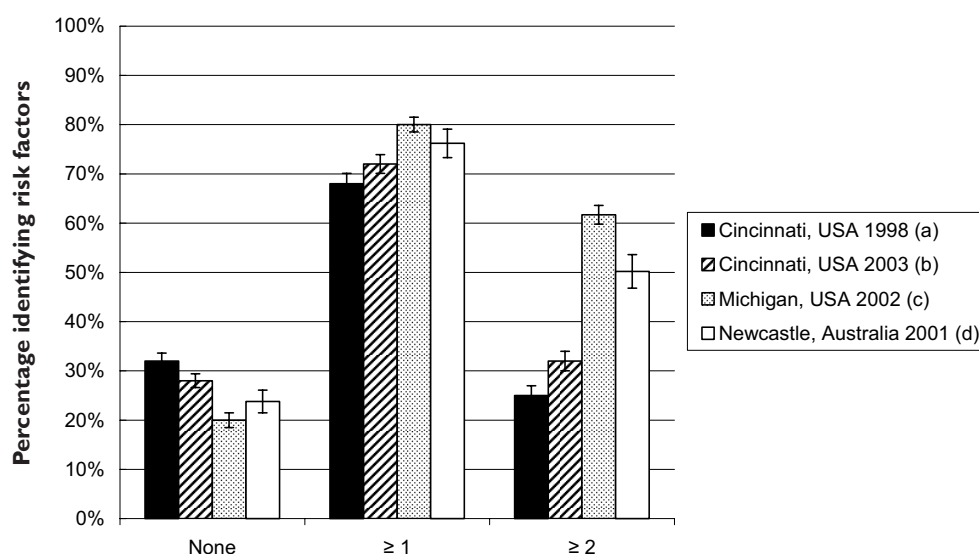
Figure 4 The number of risk factors correctly identified using free recall (community-based studies). (a) Pancioli et al 1998, (b) Schneider et al 2003, (c) Reeves et al 2002, (d) Yoon et al 2001b.

identify three risk factors for stroke using free recall correctly listed at least one of the established stroke risk factors (Figure 4). A similar study, conducted 5 years later in the same area, yielded 72% (of 2173 participants) correctly naming at least one risk factor (Schneider et al 2003). In other studies conducted in similar community groups in Australia and the USA, comparable but slightly higher proportions of people correctly identified at least one risk factor (Yoon et al 2001b; Reeves et al 2002). Interestingly, those aged ≥75 years (56%) correctly listed at least one risk factor less often than those <75 years of age (72%; p<0.001) (Pancioli et al 1998). Importantly, a minimum of 20% of people could not correctly name at least one risk factor for stroke.

The proportion of people who correctly identified at least two risk factors was significantly lower, ranging from 25% to 62% (Pancioli et al 1998; Yoon et al 2001b; Reeves et al 2002; Schneider et al 2003), and this decreased to between 24% and 28% for those identifying at least three risk factors among the two studies where this was reported (Yoon et al 2001b; Reeves et al 2002). This represents a lack of general awareness of risk factors for stroke.

Hypertension was the most commonly identified risk factor on free recall, ranging from 27.5% to 51.2% (Figure 5) (Pancioli et al 1998; Yoon et al 2001b; Reeves et al 2002; Schneider et al 2003; Carroll et al 2004). This increased to about 95% when people were provided with a list and asked to identify the risk factors for stroke (Rowe et al 2001; Parahoo et al 2003). Smoking was the next most commonly identified risk factor, being identified between 18.7% and

50.0% of the time (Pancioli et al 1998; Yoon et al 2001b; Reeves et al 2002; Schneider et al 2003; Carroll et al 2004). Interestingly, a considerable proportion of people stated that stress (21%–35%) and a poor diet (11%–32%) were risk factors (Pancioli et al 1998; Yoon et al 2001b; Reeves et al 2002; Schneider et al 2003; Carroll et al 2004). Although there is minimal evidence that these are risk factors for stroke, there seems to be general perception in the community that these factors play a major role in stroke risk. Important risk factors for stroke such as age, atrial fibrillation, and diabetes were identified by less than 5% of participants in all studies (Pancioli et al 1998; Yoon et al 2001b; Reeves et al 2002; Schneider et al 2003; Carroll et al 2004), except among those where a list was provided (Rowe et al 2001; Parahoo et al 2003). The discrepancy between studies is most likely to be because of the different manner in which the respondents were asked to identify risk factors. Awareness of risk factors may be underestimated in those asked to identify risk factors by free recall, as participants may not be clear on what is being asked or may stop after the three requested risk factors are provided. On the other hand, awareness is likely to be overestimated when people are provided with a list as it is then possible to guess the response. This is supported by the fact that conditions that are clearly not risk factors for stroke, such as cancer (26.2%), arthritis (15.4%), and poor eyesight (14.4%) were identified using this method (Rowe et al 2001). In addition, as mentioned previously, the responses for stroke warning signs were considerably better when a list was provided than when an unaided response was required.
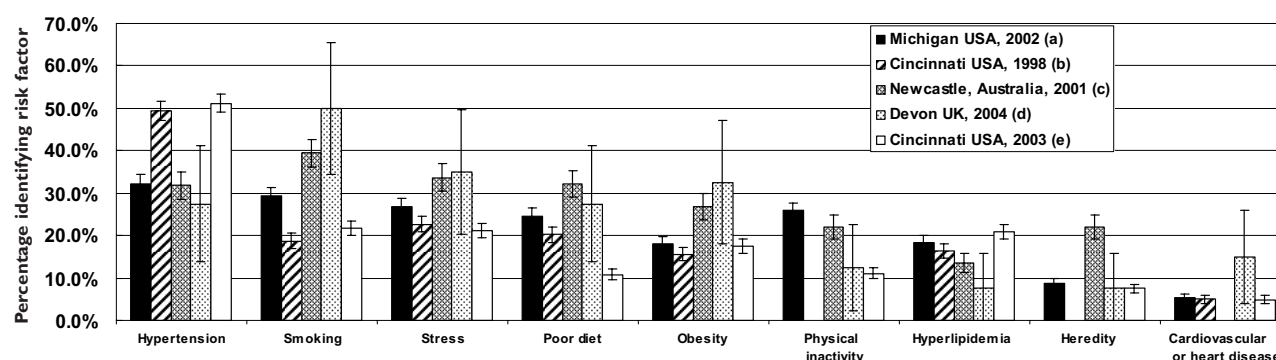
Figure 5 Community studies of awareness of stroke risk factors (free recall). (a) Reeves et al 2002, (b) Pancioli et al 1998, (c) Yoon et al 2001b, (d) Carroll et al 2004, (e) Schneider et al 2003.

Parahoo et al (2003) further asked participants to identify the main risk factor for stroke. Only 36.1% correctly identified hypertension, and 23.9% identified smoking, while the remainder predominantly stated that an unhealthy lifestyle, such as poor diet and lack of exercise, was the main risk factor. Of note is the fact that younger people (18–30 years) were more likely to identify an unhealthy lifestyle (32.8%) while those aged 65 years and over were more likely to identify hypertension (44.8%) as the main risk factor.

Knowledge of risk factors for stroke appears to be higher among those who have an established risk factor for stroke, although this argument does not hold true for older people. In their community study of 1880 participants, Pancioli et al (1998) reported that those who have a stroke risk factor (hypertension, diabetes, and smoking) were more likely to name these as stroke risk factors than those who did not have these particular risk factors (Figure 6). These findings were all statistically different and were repeated in a later study conducted in the same region (Schneider et al 2003) and in another study in the UK (Gupta and Thomas 2002). This identifies a potential opportunity for public education intervention. In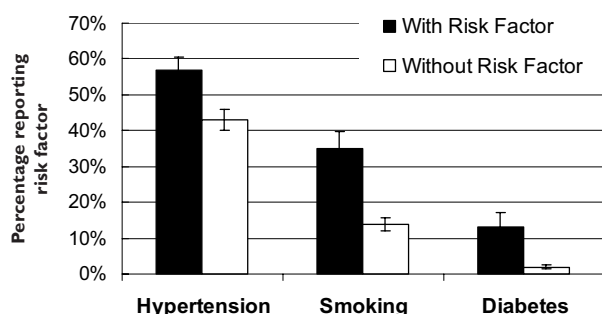 contrast, other investigators have reported that high-risk people have similar levels of awareness to those reported for community samples above (Kothari et al 1997; Carroll et al 2004). The disparity between findings most likely relates to the small number of observations in these latter two studies, thus resulting in a large degree of uncertainty about the estimates.

Not only do people with risk factors identify these factors more commonly as risk factors for stroke, they also identify themselves as being at higher risk of stroke (Yoon et al 2001a). Despite this, only 41% of high-risk people in one study were aware that they were at greater risk of stroke, and only 27% recalled being told by a physician that they were at increased risk of stroke (Samsa et al 1997). Interestingly, people with a past history of TIA were more likely to be aware that they were at increased risk of stroke (62%) than people with a history of stroke (42%) (Samsa et al 1997). Importantly, high-risk patients who were aware of their increased risk for stroke were more likely to report that they were following at least one stroke prevention practice than those who were not aware (98% versus 87%, $p < 0.01$) (Samsa et al 1997). These are significant findings as these high-risk people are the ones who need to be targeted for education campaigns.

Some investigators performed multivariate analyses to determine which factors independently predicted knowledge of stroke risk factors. The factors identified in this way were:

- younger age (Pancioli et al 1998; Reeves et al 2002; Schneider et al 2003);
- female sex (Pancioli et al 1998; Reeves et al 2002; Schneider et al 2003);
- white race (Pancioli et al 1998; Reeves et al 2002; Schneider et al 2003);
- higher level of education (Pancioli et al 1998; Reeves et al 2002; Schneider et al 2003);
- family history of stroke (Yoon et al 2001b);

Figure 6 Comparison of awareness of risk factors for stroke and presence (or absence) of a risk factor (Pancioli et al 1998).

- being hypertensive (Pancioli et al 1998; Yoon et al 2001b; Reeves et al 2002; Schneider et al 2003);
- having hypercholesterolemia (Schneider et al 2003);
- drinking more than two alcoholic drinks per day (Schneider et al 2003);
- having poor health (Reeves et al 2002).

Furthermore, the strongest predictors of awareness of self-risk of stroke were TIA, younger age, and poor current health status (p < 0.001) (Samsa et al 1997). There appears to be a lack of knowledge about risk factors for stroke among diverse groups of people, particularly older people, males, and those with less education. It may be that targeting these specific groups for risk factor awareness and prevention campaigns may be the most effective way of improving awareness in the population.

Knowledge that reducing/treating risk factors will reduce likelihood of stroke

Few investigators have assessed whether people are aware that stroke is preventable and that behavior can be changed to modify risk. In an urban community sample of 822 participants, 23% considered strokes only slightly or not at all preventable, while 70% considered stroke to be moderately or completely preventable (Yoon et al 2001a). If high-risk patients are unaware that preventive practices can reduce their likelihood of a stroke, then there is little, if any, impetus to change behaviors. This specific information may need to be included in any preventive campaigns.

In summary, there is a lack of knowledge about stroke risk factors among the population, although those at higher risk seem to be more aware. The elderly, males, and those with lower educational attainment are less aware of risk factors and may need to be a focus of risk prevention/awareness strategies. Finally, there is limited evidence of peoples' knowledge about the ability to reduce their risk of stroke. Behavioral change is the ultimate goal if improvement in risk factor self management is the desired outcome. Although knowledge or awareness do not necessarily equate to behavioral change, the knowledge that changing behavior can reduce stroke risk may be important in altering an individual's behavior and is an area that could be a focus of future research.

There is a great deal of variation in the methodology used in the studies reviewed here, particularly in terms of the size of the population being studied. The largest study (Greenlund et al 2003) covered an enormous geographic range and more than 61 000 people, while the smallest study (Carroll et al 2004) comprised a total of 40 individuals. Those studies conducted in higher risk groups tended to have study participants with a higher mean age than the community-based studies, a result that is not entirely surprising as stroke risk increases with age. The age difference between the high-risk and population-based studies could also explain some of the variation among the findings of the studies reported here. As mentioned previously, the use of open- and closed-type questions can also have some degree of influence on survey outcomes.

Knowledge of stroke warning signs was generally low in the studies where respondents were asked to identify these signs without prompting, and improved substantially in those studies where warning signs were identified from a list. Regression analysis of predictors of increased knowledge of stroke warning signs identified younger age and higher education levels as the most common factors associated with improved knowledge. It is apparent from the studies reviewed here that public levels of awareness of stroke warning signs and risk factors are relatively low, notably in the higher risk, older age groups. There is a need for public health campaigns to address this knowledge gap, with high-risk groups being of primary concern.

Acknowledgments

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