Does the Influence of Stroke on Dementia Vary by Different Levels of Prestroke Cognitive Functioning?
A Cohort Study

Alex Dregan, PhD; Charles D.A. Wolfe, MD; Martin C. Gulliford, FFPH

Background and Purpose—The association between stroke and subsequent dementia or Alzheimer disease is well established. What is less understood is the extent to which this association is dependent on prestroke cognitive functioning. The study estimated the occurrence in poststroke dementia as a function of prestroke cognitive status and incident stroke.

Methods—Study data were derived from the English Longitudinal Study of Ageing, a 10-year long prospective cohort study of older adults living in England. Baseline data (2002/2003) were used to group participants into tertiles of cognitive, memory, and executive functioning before an incident stroke. Data from 4 follow-up surveys were used to identify new stroke and poststroke dementia events.

Results—The analyses were based on 10,809 participants aged \( \geq 50 \) years at baseline. High prestroke executive functioning was associated with lower relative risk (RR) of dementia (RR, 0.24; 95% confidence interval, 0.13–0.45; \( P < 0.001 \)). Stroke was associated with increased RR of poststroke dementia (RR, 2.63; 95% confidence interval, 1.80–3.84; \( P < 0.001 \)). The association of stroke with poststroke dementia was greater for participants with higher prestroke executive functioning (interaction term RR, 4.4; 95% confidence interval, 1.35–14.63; \( P = 0.014 \)). For participants with higher executive functioning, the probability of dementia was 0.3% without stroke and 3.1% after stroke, compared with 1.9% and 5.2% for lower executive functioning.

Conclusions—Stroke and prestroke cognition were independently associated with increased probability of poststroke dementia. Stroke results in disproportionate increase in the risk of dementia when premorbid cognitive functioning is high. (Stroke. 2013;44:3445-3451.)

Key Words: cognition ■ dementia ■ stroke

Stroke and dementia (including Alzheimer disease [AD] and vascular dementia) represent heterogeneous syndromes with diverse pathogenesis and are increasingly viewed as interrelated conditions sharing similar risk factors and pathological mechanisms.1–4 Several reviews and cohort studies suggested a doubling of the risk of dementia after stroke.5–12 There is also evidence, although less available, that cognitive impairment may increase the risk of incident stroke.13,14 What is less understood is the extent to which the probability of dementia after stroke is dependent on prestroke cognitive status. In other words, is the influence of stroke on poststroke dementia similar for participants with different levels of prestroke cognitive functioning?

A recent review9 concluded that the influence of stroke on the risk of poststroke dementia may be independent of prestroke cognitive functioning. The major concern with existing evidence is that prestroke cognitive functioning was assessed shortly after a stroke event, potentially confounding cognitive functioning with transient stroke effects. One of the few studies10 to assess cognitive functioning before an incident stroke seemed to support the suggestion of Pendlebury and Rothwell9 for an independent effect of stroke on subsequent dementia. However, evidence concerning the possible influence of stroke on poststroke dementia may vary across distinctive cognitive domains (ie, memory and executive functioning) or across different abilities within the same cognitive domain is less available. Investigating the link among prestroke cognition, stroke, and poststroke dementia can facilitate a better understanding of the possible pathogenesis of poststroke dementia. For instance, if prestroke cognition is associated with poststroke dementia, this could be seen as a continuum of cognitive disorder that tends to deteriorate as people get older, and stroke may have a secondary effect by accelerating this early deterioration.

A previous study suggested that prestroke executive impairment might also be associated with the risk of poststroke disability.15 The present study used a prospective cohort of adults aged \( \geq 50 \) years to evaluate whether the influence of stroke
on poststroke dementia is dependent on prestroke cognitive status, and that this relationship varies across distinctive domains of cognitive functioning (ie, memory and executive functioning).

Methods

The data for the present study were derived from the English Longitudinal Study of Ageing (ELSA), a prospective cohort study of adults aged ≥50 years living in England. Participants were followed up biannually from 2002/2003 to 2010/2011 providing a 10-year follow-up period and including around 10000 participants at each survey. Steptoe et al18 provided a detailed description of the ELSA study.

Cognitive Measures

The study cognitive measures have been detailed in a previous study17 and are only summarized here. Baseline (2002/2003) data were used to develop 3 cognitive measures, including memory, executive functioning, and a cognitive index. The memory index was assessed using 4 tasks: immediate recall, delayed recall, prospective memory test, and day and date questions. For the immediate and delayed verbal memory tasks, participants were asked to recall as many as possible of 10 common nouns immediately and also after completion of other cognitive tests. The prospective memory task asked participants to remember to write their initials in the top left-hand corner of a page when handed to them and to remember to remind the interviewer to record the time of the cognitive testing section finished. These tests are similar to the ones used in the Medical Research Council Cognitive Function and Ageing Study (MRC CFAS)19 and Rivermead Behavioural Memory Test.20 Day and date questions from the mini-mental state examination21 were used to assess time orientation. The executive functioning index involved 3 separate tests: verbal fluency, mental speed, and visual scanning abilities. The verbal fluency task involved the participants naming as many different animals as possible within 1 minute. The letter cancellation test is based on the MRC National Study of Health and Development (NHSD).21 Participants are asked to cross out as many of the 65 P and W letters as possible in 1 minute on a page, including 780 random letters in a grid. The total number of letters searched provides a measure of mental speed, whereas the ratio of correctly identified target letters to all target letters within the scanned section provides a measure of attention.22 Because the scoring of each individual cognitive test varies, test scores were standardized to give a mean of 0 and a SD of 1 (z scores). Participants' z scores on the memory and executive indexes were summed up and averaged into an overall cognitive index. These tests were delivered face to face by interviewers who were trained by qualified researchers in the use of computerized-assisted personal interviewing.

Stroke

Data from the each follow-up surveys were used to identify incident stroke events. At each follow-up, participants were asked whether a medical doctor has diagnosed them with a new stroke event since the last survey. The month and year of the diagnosis were also recorded. At subsequent surveys participants were asked to reconfirm previous reports of stroke diagnosis allowing for validation of diagnosis consistency. Stroke data were used to classify participants into stroke (incident stroke at any of the 2 surveys) or no stroke (no incident stroke) binary variable. Glymour and Avendano23 confirmed the reliability of self-reported stroke incidence and associated risk factors in the Health and Retirement Study (HRS), which is the US counterpart of the ELSA. The reliability of self-reported stroke in epidemiological research has been validated in other population-based studies.24 Also, 80% of randomly selected participants were contacted by telephone to confirm key details in the interview, including medical diagnoses.

Dementia and AD

Poststroke dementia is defined as incident vascular dementia and AD after a stroke incidence. The study did not impose a time limit on poststroke dementia because the timing of diagnoses are arbitrary and can appear at any time after a stroke incidence.25 Given that mixed pathologies are common, it is often difficult to determine whether cognitive deterioration is solely a consequence of vascular factors or underlying AD.26 Data from each follow-up survey were used to identify poststroke incident dementia and AD events. Participants or their proxy respondents were asked to report whether, and if so when, they were diagnosed by a medical doctor with dementia or AD since the last survey. This information was used to develop a binary (yes/no) outcome measure that included either dementia or AD diagnoses. For about a quarter to third of dementia participants the survey was conducted via a proxy person—mainly natural son or daughter. If cognitive impairment prevented the participant from answering this question, their partner or an adult family member who knew the participant well was used to identify a dementia diagnosis. With each follow-up survey participants or their proxy respondents were asked to reconfirm prior survey diagnosis of dementia or AD. At the last survey, participants reported the study survey at which they were first diagnosed with dementia or AD. Only reconfirmed diagnoses were accepted as valid cases.

Covariates

Aside from age (continuous) and sex (female/male), highest educational qualification grouped participants into no qualification; level 1 National Vocational Qualification or Certificate of Secondary Education; NVQ2 or O-level; NVQ3 or A-level; higher qualification but below degree; and degree level or higher or NVQ 4/5. Social class was included as a 6-category variable: professional, managerial, skilled nonmanual, skilled manual, semiskilled manual, and unskilled manual. As Håkansson et al27 suggested that cohabitation was associated with reduced risk of cognitive impairment and AD in later life, partnership status was included as a binary (married or partnership versus single) covariate in the analyses. Smoking was assessed according to participants' number of cigarettes smoked per day. Based on participant-reported frequency of physical activity, a 4-category physical exercise variable was created: sedentary, low, moderate, and highly active. An abbreviated Center for Epidemiological Studies Depression Scale28 measure was used to create a continuous measure of depressive symptoms (scores ranged from 0 to 8). Diabetes mellitus (present/absent) and hypertension (present/absent) were also included as covariates given their strong association with both stroke and dementia.

Analysis

According to their standardized scores on the 3 cognitive measures, participants were divided into tertiles (lowest, second, and highest) of cognitive, memory, and executive functioning. This approach provided for testing whether the influence of stroke on dementia probability varies across defined levels of cognitive functioning. The outcome measure for the analysis was represented by the combined diagnoses of dementia or AD. Multivariate Poisson regression analysis with robust SEs were used to model the main and interaction effects between prestroke cognitive functioning with incident stroke on the risk of poststroke dementia. A fully interacted model was fitted as it was expected that the influence of stroke will vary by different levels of prestroke cognitive functioning. The reference group in the interaction models was represented by the combination of lowest tertile of prestroke cognitive functioning with no stroke. Postestimation predXct command in Stata was used to predict the adjusted probabilities of dementia for the interaction effects. Finally, the analyses explored the adjusted predictive power of prestroke cognition on subsequent stroke and poststroke disability. All analyses were adjusted for diabetes mellitus, hypertension, smoking, depression, physical activity, educational qualifications, social class, marital status, age, and sex. Sensitivity analyses using missing indicator variable approach to deal with attrition problems gave similar results to full data analysis. The analyses were weighted for the probability of nonresponse and were conducted using Stata version 12. A 0.05 limit was set for statistically significant effects.
Results
A total of 754 participants were excluded initially because they had a stroke diagnosis (n=656) or dementia diagnosis (n=76) before or at baseline or had a diagnosis of stroke after dementia (n=22). This procedure ensured that both stroke and dementia diagnoses were subsequent to baseline cognitive assessment and reduced the risk of reverse causality. After the exclusion of ineligible participants, 10809 core members from baseline survey were retained in further analyses. Mean age of participants (Table 1) was 64.88 years, 42% gained no educational qualifications, and women represented 55% of the sample.

Table 2 shows that ≈2% of the participants reported a new stroke event at each of the follow-up surveys. There was a clear increasing trend in new dementia events with each follow-up survey, from ≈1% (n=56) at first follow-up to 2% (n=122) at the final follow-up survey. Notably, there was a 7-fold increment in the proportion of patients with stroke diagnosed with poststroke dementia between 2004/2005 (3%) and 2010/2011 (22%) surveys.

The Figure graphs the mean changes in cognitive scores over time for participants with an incident stroke at first follow-up survey. The graph reveals almost a 40% decline in mean executive functioning scores for stroke participants from baseline to the fourth survey (cognitive data were not available at the time of the study). The largest decline (24%) was observed from the prestroke survey to the follow-up survey immediately after the stroke. For nonstroke participants the decline in mean cognitive and executive functioning scores was 3.8 lower (12%). For memory scores, the decline was observed 4 years after the incident stroke and was stronger among stroke participants than nonstroke participants (17% versus 5%).

Table 3 data indicate that among the highest tertile of executive functioning, having a stroke was associated with a 4-fold (relative risk [RR], 4.44; 95% confidence interval [CI], 1.35–14.63; P=0.014) increase in adjusted RR of dementia compared with no stroke. The overall test for interaction effects was also statistically significant (λ=6.63; P=0.036). A statistically significant effect was also observed for the interaction between cognitive score and stroke on the risk of dementia (RR=3.99; 95% CI, 1.27–12.55; P=0.018); however, the overall test for interaction effects was just outside the 0.5 level of statistical significance (λ=.569; P=0.058). Notably, when the analyses were stratified by stroke, prestroke memory scores in the second tertile significantly attenuated the RR of poststroke dementia (RR=0.33; 95% CI, 0.14–0.82; P=0.017), compared with lowest tertile of memory scores. Similar finding was observed for the cognitive index.

With respect to main effects analyses, Table 3 data reveal a lower RR of poststroke dementia for participants in the second and highest tertiles of cognitive functioning compared with those in the lowest tertile. Conversely, an incident stroke was associated with 2.66 greater RR of poststroke dementia (95% CI, 1.80–3.84; P<0.001) compared with no-stroke incident.

The interactions effects are further illustrated in Table 4, which shows the difference in adjusted probabilities of poststroke dementia for different combinations of prestroke cognition and stroke. The results revealed that at the highest tertile of executive functioning, having a stroke increased 10-fold the probability of poststroke dementia comparing with the absence of an incident stroke (0.3%–3.1%). The difference of
poststroke dementia was significantly less at the lowest tertile of executive functioning (1.9%–5.2%).

Finally, participants in the highest tertile of executive functioning at baseline showed reduced RR (RR, 0.69; 95% CI, 0.50–0.95; \( P=0.021 \)) of an incident stroke compared with participants in the lowest tertile of executive functioning (Table 5). Also, being in the highest tertile of executive functioning lowered significantly the risk of poststroke complications (\( \beta=0.02; \ 95\% \ CI, -0.04 \text{ to } -0.01; \ P=0.002 \)). Similar patterns emerged for memory and cognitive functioning indexes.

**Discussion**

In a prospective design of older adults, free from stroke at baseline, both incidence stroke and lower baseline cognitive

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**Table 3.** Adjusted* Relative Risk (95% Confidence Interval) of Dementia as a Function of Prestroke Cognition, Stroke, and Interaction Effects Between Prestroke Cognition and Stroke

<table>
<thead>
<tr>
<th>Prestroke cognitive tertile</th>
<th>Cognitive RR (95% CI)</th>
<th>( P ) Value</th>
<th>Memory RR (95% CI)</th>
<th>( P ) Value</th>
<th>Executive RR (95% CI)</th>
<th>( P ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest tertile</td>
<td>Ref</td>
<td></td>
<td>Ref</td>
<td></td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Second tertile</td>
<td>0.36 (0.24–0.52)†</td>
<td>&lt;0.001†</td>
<td>0.33 (0.23–0.49)†</td>
<td>&lt;0.001†</td>
<td>0.60 (0.43–0.85)†</td>
<td>0.004†</td>
</tr>
<tr>
<td>Highest tertile</td>
<td>0.21 (0.12–0.38)†</td>
<td>&lt;0.001†</td>
<td>0.25 (0.15–0.42)†</td>
<td>&lt;0.001†</td>
<td>0.24 (0.13–0.45)†</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>Stroke (yes vs no)</td>
<td>2.61 (1.80–3.79)†</td>
<td>&lt;0.001†</td>
<td>2.54 (1.77–3.66)†</td>
<td>&lt;0.001†</td>
<td>2.63 (1.80–3.84)†</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>Prestroke cognition×stroke</td>
<td>Stroke and second tertile</td>
<td>1.04 (0.33–3.28)</td>
<td>0.946</td>
<td>1.30 (0.48–3.55)</td>
<td>0.610</td>
<td>0.76 (0.76–4.11)</td>
</tr>
<tr>
<td>Stroke and highest tertile</td>
<td>3.99 (1.27–12.55)†</td>
<td>0.018†</td>
<td>2.17 (0.70–6.66)</td>
<td>0.177</td>
<td>4.44 (1.35–14.63)†</td>
<td>0.014†</td>
</tr>
</tbody>
</table>

Stratified analyses

<table>
<thead>
<tr>
<th>No stroke</th>
<th>Cognitive RR (95% CI)</th>
<th>( P ) Value</th>
<th>Memory RR (95% CI)</th>
<th>( P ) Value</th>
<th>Executive RR (95% CI)</th>
<th>( P ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest tertile</td>
<td>Ref</td>
<td></td>
<td>Ref</td>
<td></td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Second tertile</td>
<td>0.36 (0.24–0.55)†</td>
<td>&lt;0.001†</td>
<td>0.32 (0.21–0.49)†</td>
<td>&lt;0.001†</td>
<td>0.55 (0.38–0.81)†</td>
<td>0.002†</td>
</tr>
<tr>
<td>Highest tertile</td>
<td>0.17 (0.08–0.33)†</td>
<td>&lt;0.001†</td>
<td>0.22 (0.13–0.40)†</td>
<td>&lt;0.001†</td>
<td>0.19 (0.09–0.38)†</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>Stroke</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest tertile</td>
<td>Ref</td>
<td></td>
<td>Ref</td>
<td></td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Second tertile</td>
<td>0.32 (0.12–0.83)†</td>
<td>0.019†</td>
<td>0.33 (0.14–0.82)†</td>
<td>0.017†</td>
<td>0.75 (0.36–1.54)</td>
<td>0.425</td>
</tr>
<tr>
<td>Highest tertile</td>
<td>0.57 (0.18–1.79)</td>
<td>0.333</td>
<td>0.43 (0.17–1.12)</td>
<td>0.087</td>
<td>0.62 (0.19–2.00)</td>
<td>0.427</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; and RR, relative risk.

*Adjusted for age, education, diabetes mellitus, hypertension, smoking, physical activity, depression, social class, marital status, and sex.

†Significant at \( P<0.05 \) or lower level of statistical significance.

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**Figure.** Trends in mean cognitive scores for participants with or without a new stroke event at the second follow-up (2004–2005). Enlarged square represents the first poststroke survey.
functioning were independently associated with increased risk of poststroke dementia. The findings also suggest that the RR of poststroke dementia may vary according to pre-morbid cognitive functioning. Based on the study results, it seems that stroke has a greater impact on the risk of poststroke dementia among participants with higher prestroke executive functioning. Thus, the observed interaction effects seemed to be explained by the substantially larger increment in probability of dementia after stroke at the highest level of executive functioning compared with the same differences at the lowest level of executive functioning. The lack of interaction effects between prestroke memory with stroke on the risk of poststroke dementia may suggest that the observed effects may be specific to the cognitive domain specific of executive functioning. This suggestion is supported by the results of stroke-stratified analyses, where only prestroke memory scores seemed to significantly lower the risk of poststroke dementia. The correlation between prestroke cognitive functioning and poststroke disability reflects the higher levels of prestroke brain function that may protect against the deleterious effects of a cerebrovascular accident.

**Comparison With Previous Studies**

Previous studies have not found evidence for an interaction effect between stroke and prestroke cognitive functioning on the risk of poststroke dementia. The present study suggested that when assessing the effects of incident stroke across different prestroke cognitive groups and testing potentially

Table 4. Adjusted* Predicted Probabilities (Expressed as a Proportion) of Dementia for Stroke and Nonstroke Participants at Different Levels of Cognitive Functioning

<table>
<thead>
<tr>
<th>Stroke</th>
<th>Cognitive</th>
<th>Memory</th>
<th>Executive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Probability (%) of Dementia (95% CI)</td>
<td>n</td>
</tr>
<tr>
<td>Lowest tertile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No stroke</td>
<td>2375</td>
<td>1.9 (1.4–2.6)</td>
<td>2486</td>
</tr>
<tr>
<td>Stroke</td>
<td>169</td>
<td>5.2 (2.6–8.5)</td>
<td>163</td>
</tr>
<tr>
<td>Middle tertile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No stroke</td>
<td>2865</td>
<td>0.07 (0.05–1.1)</td>
<td>3009</td>
</tr>
<tr>
<td>Stroke</td>
<td>99</td>
<td>1.5 (0.05–4.1)</td>
<td>114</td>
</tr>
<tr>
<td>Highest tertile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No stroke</td>
<td>3117</td>
<td>0.3 (0.2–0.6)</td>
<td>3065</td>
</tr>
<tr>
<td>Stroke</td>
<td>76</td>
<td>3.1 (1.1–8.2)</td>
<td>84</td>
</tr>
</tbody>
</table>

CI indicates confidence interval.
*Probability adjusted according to age, education, diabetes mellitus, hypertension, smoking, physical activity, depression, social class, marital status, and sex.

Table 5. Adjusted* Relative Risk and Standardized β (95% Confidence Interval) for Stroke and Poststroke Disability Risk as a Function of Prestroke Cognitive Scores

<table>
<thead>
<tr>
<th>Stroke†</th>
<th>Poststroke Disability‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR (95% CI)</td>
<td>P Value</td>
</tr>
<tr>
<td>Cognitive</td>
<td></td>
</tr>
<tr>
<td>Lowest tertile</td>
<td>Ref</td>
</tr>
<tr>
<td>Second tertile</td>
<td>0.73 (0.56 to 0.94)§</td>
</tr>
<tr>
<td>Highest tertile</td>
<td>0.74 (0.54 to 1.01)</td>
</tr>
<tr>
<td>Memory</td>
<td></td>
</tr>
<tr>
<td>Lowest tertile</td>
<td>Ref</td>
</tr>
<tr>
<td>Second tertile</td>
<td>0.82 (0.64 to 1.04)</td>
</tr>
<tr>
<td>Highest tertile</td>
<td>0.80 (0.60 to 1.06)</td>
</tr>
<tr>
<td>Executive</td>
<td></td>
</tr>
<tr>
<td>Lowest tertile</td>
<td>Ref</td>
</tr>
<tr>
<td>Second tertile</td>
<td>0.72 (0.56 to 0.92)§</td>
</tr>
<tr>
<td>Highest tertile</td>
<td>0.69 (0.50 to 0.95)§</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; and RR, relative risk.
*Adjusted for age, education, diabetes mellitus, hypertension, smoking, physical activity, body mass index, depression, and sex. Analyses weighted for nonresponse.
†All stroke incidences at the subsequent waves (2004/5 to 2010/11).
‡Based on 4 main poststroke disabilities: arms or legs weakness, speaking or swallowing, vision, and thinking or finding the right words.
§Significant at P<0.05 or lower level of statistical significance.
separate cognitive domains, the effect of stroke on poststroke dementia risk may depend on prestroke cognitive functioning levels. Previous studies also used mini-mental state examination, which is known to have low sensitivity in detecting executive functioning impairment.20

Stroke has been previously linked9–12,23,24 with increased risk of poststroke dementia, and the present study confirm these evidence using different definitions of dementia in older adults. The finding that high prestroke cognitive functioning has an independent negative effect on the probability of poststroke dementia is also supportive of previous suggestions28 and extends these findings to different cognitive functioning domains. The protective effect of high prestroke executive functioning on the risk of stroke is less established,14 and the present findings showed a similar effect on stroke severity.

**Strengths and Limitations**

The present study has several strengths, including the use of a nationally representative sample of older adults, availability of measures assessing distinctive cognitive domains, and long-term follow-up. The prospective nature of the data allowed for the temporal order among prestroke cognition, incident stroke, and poststroke dementia or AD. The memory and executive function tests were selected by the ELSA research team informed by evidence of the reliability and validity and wide use of these memory and executive functioning tests.18,21 Many of these tests have been used in a similar fashion in other important aging studies (eg, HRS, MRC CFAS, and NHSD), which should facilitate replications of the present findings.

Several limitations common to observational studies need mentioning. At present, there is no simple test to diagnose dementia or AD in community populations and, similar to previous studies, dementia diagnosis was based on self-reports. This concern is also pertinent to stroke diagnosis. Misclassification bias, particularly in the lowest ability tertiles, is also a possibility given the high rates of undiagnosed dementia in community samples. This is an issue affecting all studies on dementia. The finding of interaction effects across all levels of executive functioning tertile in the present study mitigates to some extent against the issue of misclassification bias. Another important advantage of ELSA data is that it was possible to corroborate data about timing and type of diagnosis across diverse surveys and questions minimizing reporting bias. We cannot exclude the possibility of prestroke microvascular diseases that are related to executive functioning deficits.39 The risk of dementia in stroke participants was similar across the 3 tertiles of prestroke executive functioning suggesting that this effect was possibly minimal here. Also, the significant association between poststroke severity and prestroke executive index after adjusting for vascular factors (ie, hypertension, diabetes mellitus) limits the possibility that the association was confounded by microvascular events. Attrition problems are common in longitudinal studies and the present data are no exception. Mortality from stroke might be related to cognitive functioning and differential survival after stroke may confound the study observations. Another limitation of the present data is that it is not possible to identify the specific tests used for dementia or AD diagnosis by the doctor. However, misclassification would generally be expected to reduce the magnitude of associations. Thus, our findings may underestimate the strength of the association among prestroke cognition, stroke, and poststroke dementia. The study used baseline weights to adjust for nonresponse probability and conducted sensitivity analyses using multiple imputation. Multiple imputation can be a superior method to handle missing data, if data are missing at random. However, this assumption is difficult to verify and different imputation methods can give different results.31 Although the study included larger number of dementia or AD participants than previous studies, it is likely that there was only limited power to test interaction effects, which may explain why results were not entirely consistent for each measure of cognitive functioning. The prospective memory test can be thought of as an overlap of memory and executive domains, and often tasks from 1 domain trigger processes from other domains. Also, early studies suggested that animal naming may not be sufficiently sensitive to tap all cognitive components of Dysexecutive syndrome.32 However, Salthouse et al33 identified verbal fluency tests as the best measure of executive functioning and together with letter fluency correlated strongly to reasoning ability and perceptual speed.34 Future studies with more extensive cognitive ability tests could extend present findings to other domains of executive functioning, such as language and goal setting.

**Implications**

These findings draw attention to the adverse effects of stroke on the long-term cognitive functioning of stroke survivors. The results suggest that the impact of stroke may be particularly deleterious in people with better cognition before stroke although this effect may be domain specific. This suggestion points to the need to identify early signs of cognitive decline after stroke and to develop, evaluate, and promote interventions that may protect against progressive loss of cognitive functioning in these patients.

Executive functioning abilities are critical to people’s ability to solve problems, develop, and perform plans and interpreting and responding adequately to social information.35 These abilities are often impaired in patients with stroke, with serious negative consequences for survivors’ quality of life and ability to manage their condition and increasing their risk of dementia. The present study suggests that although stroke increases the risk of dementia at all cognitive levels, higher executive and memory skills can attenuate to some extent the risk of poststroke dementia. The finding that this attenuation was not statistically significant, however, emphasizes the need to consider the multifactorial nature of poststroke dementia prevention. It may be, for instance, that interventions aimed at improving or protecting executive functioning and reducing vascular risk may prove the most promising approach.

In stratified analyses, high prestroke cognitive and memory ability seemed to lower the risk of poststroke dementia, suggesting that boosting older adults’ cognition and memory could prevent or delay the onset of poststroke dementia. This suggestion is supported by the reduced risk of stroke and poststroke disability associated with high prestroke executive and memory scores. Overall, early identification of executive functioning and memory deficits and development of compensatory mechanisms may prevent or postpone the development
of 2 of the most debilitating conditions in older adults. UK government proposals to encourage general practitioner’s to test older adults’ memory status during routine consultations could facilitate early identification of cognitive deficits in the general population. Patients could then be referred to tailored interventions according to the type and cause of their cognitive deficits (ie, vascular risk prevention, and episodic memory training). Most existing cognitive tests undermine the value of distinctive cognitive domains, and present findings endorse the use of tests reflective of separate cognitive abilities. These suggestions need to be seen in the light of current study limitations and need to be confirmed by future studies with larger samples.

Sources of Funding
The work of the authors was supported by the National Institute for Health Research Biomedical Research Center at Guy’s and St Thomas’ National Health Service Foundation Trust and King’s College London. The views expressed are those of the author(s) and not necessarily those of the National Health Service, the National Institute of Health Research, or the Department of Health.

Disclosures
None.

References
Does the Influence of Stroke on Dementia Vary by Different Levels of Prestroke Cognitive Functioning?: A Cohort Study
Alex Dregan, Charles D.A. Wolfe and Martin C. Gulliford

Stroke. 2013;44:3445-3451; originally published online October 17, 2013;
doi: 10.1161/STROKEAHA.113.002990

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