Prospective Follow-Up Study Between 3 and 15 Months After Stroke

Improvements and Decline in Cognitive Function Among Dementia-Free Stroke Survivors >75 Years of Age

Clive Ballard, MD, MRCPsych; Elise Rowan, PhD; Sally Stephens, BSc; Raj Kalaria, PhD, FRCPath; Rose Anne Kenny, MD, FRCP

Background and Purpose—Poststroke cognitive impairment is frequent. There are, however, few longitudinal studies examining delayed changes in poststroke cognition.

Methods—As part of a longitudinal study of incident dementia after stroke, 115 older stroke survivors (>75 years of age) without dementia were evaluated at 3 and 15 months with a detailed neuropsychological evaluation (including memory, attention, executive performance, and language).

Results—we found that 9% of older stroke patients developed incident dementia, with significant deterioration in global cognition, memory, and attention. Only the severity of expressive language performance at 3 months was associated with dementia at follow-up. Conversely, 57 patients (50%) experienced some improvement in global cognition. None of the criteria for early cognitive impairment identified people at increased risk for dementia.

Conclusions—Delayed dementia is frequent in older stroke patients, but current criteria for early cognitive impairment are not useful as predictors of cognitive deterioration. Improvement in cognition occurred in most patients. (Stroke. 2003; 34:2440-2445.)

Key Words: dementia ■ elderly ■ stroke

Twenty-five percent of stroke survivors have dementia after stroke,1–3 and the delayed development of incident dementia remains up to 9 times greater than among an age-matched population for ≥5 years after stroke.4 Prevalence rates and probably incidence rates are even higher among older stroke survivors.5–7 To identify individuals at particular risk of progressive cognitive decline and hence to target interventions for secondary prevention, it is imperative to identify early predictors.

Decline in cognitive function, however, is not inevitable. Desmond et al8 identified delayed improvement in cognitive function in ≈10% of stroke patients (mean age, 70 years) between 3 and 15 months after stroke. A further study of a younger stroke cohort (mean age, 60 years) indicated that >30% of subjects who had mild cognitive impairments between 0 and 6 months after stroke improved and could be classified as cognitively intact by 12 to 18 months.9 It is unknown whether cognitive improvement is also common in older stroke patients.

The most widely used concept for early cognitive deficits is mild cognitive impairment10 (MCI), which focuses on memory deficits to identify “pre-Alzheimer’s disease.” Whether the concept is useful in the context of cerebrovascular disease is less clear.11 Other frequently used concepts include aging-associated cognitive decline (AACD),12 which can be applied to impairments in any cognitive domain, and cognitive impairment, no dementia (CIND),13–15 which relates to global cognitive performance but can attribute potential etiology to cerebrovascular disease, when it is referred to as Vascular CIND. There are no longitudinal studies of the predictive value of these different concepts specifically in stroke survivors. In addition, although global cognitive impairment is frequent after stroke,16–19 it has not been determined whether specific task impairments predict subsequent dementia in stroke patients.

Methods

Participants

Stroke patients ≥75 years of age were recruited from representative hospital-based stroke registers in Tyneside and Wearside (UK). Stroke was defined according to the World Health Organization definition.20 The patient cohort was assessed comprehensively at 3 months after stroke with a standardized battery. Three months was chosen for baseline measures on the basis of the design of Desmond et al8 and to enable resolution of acute poststroke delirium. The
Neuropsychological Evaluations
The Cambridge Assessment Mental Disorders in the Elderly, section B (CAMCOG) is a standardized paper and pencil test (maximum score, 107) for global cognitive performance. The schedule includes subscores for memory, orientation, language comprehension, language expression, attention, praxis, calculation, abstract thinking, perception, and executive function.

The Cognitive Drug Research (CDR) computerized battery has been widely used for the evaluation of attention/processing speed and executive function in elderly control subjects24 and dementia patients. Tests include Simple Reaction Time, Choice Reaction Time (CRT), Digit Vigilance, Memory Scanning (numerical working memory), and Spatial Memory (visuospatial working memory task). Within-trial variability (SD) in the measures of CRT is assessed in single trials lasting ~90 seconds; this is referred to as the CRT SD, which has been shown to be a good indicator of impaired consciousness,25 and hence is used as an indicator of possible delirium.

Other components of the battery include the Boston Naming Test,26 the FAS Verbal Fluency Test,27 and the Mini Mental State Examination (MMSE).28

Assessment of Early Cognitive Decline
Standardized criteria for MCI,29 AACC22 (with CRT as an attentional task and spatial working memory as a task related to executive function), and vascular CIND14 were applied at the 3- and 15-month assessments. Subjects were classified as having MCI with the criteria of Petersen et al10 (a score <17.6 on the total memory score of the CAMCOG was 1.5 SD below the level of the age-matched control group). Vascular CIND was diagnosed if (1) people did not meet DSM IV criteria for dementia, (2) the CAMCOG total score was <20, and (3) a diagnosis of vascular CIND was consistent with a clinical judgment based on direct examination, evaluation of neuropsychological tests, informant interview, and assessment of functional activities.14 People were classified as AACC according to CRT if the mean CRT was >584.7 milliseconds and according to spatial memory sensitivity (score >39%). These cutoff values were based on performance >1 SD below the mean from the age-matched control population as stipulated in the criteria.19

Statistical Analysis
Previous studies evaluating the MMSE have determined that changes of >2 points are beyond the threshold of chance variability.29,30 Therefore, at a 1-year follow-up, participants were classified as improvers if there was an improvement of >2 points in MMSE score, as decliners if they developed dementia (DSM IV criteria), and as remaining stable if they did not experience either of these outcomes. The proportion of people improving or developing dementia and the proportion of people meeting MCI, AACC, and vascular CIND were determined. For each evaluation, the 95% confidence intervals (CIs) were calculated. Baseline performance at 3 months after stroke and changes in individual tasks were compared between decliners, improvers, and those who were stable with the Mann-Whitney U test. These groups were compared in pairs because the key clinical questions relate to the differences between patients who improve or decline and those who remain stable; it could not be assumed that an overall analysis of the 3 groups with analysis of variance would not mask specific differences between individual groups. A nonparametric method (the Wilcoxon signed-rank test) was used to evaluate serial changes because a number of the parameters evaluated (particularly aspects of attentional performance) are not normally distributed. The proportion of people meeting each of the criteria applied for early cognitive impairment who experienced subsequent cognitive decline is described. All statistical evaluations were undertaken with the SPSS computer software program.31

Outcome at 15 Months

Dementia
At the 15-month assessment, 36 people (31%; 95% CI, 20 to 42) experienced some drop in MMSE (from an average of 26.6±2.5 to 24.1±3.3 points; z=5.3; P<0.0001), with 10 (9%; 95% CI, 6 to 12) developing incident dementia. Over the 12 months between assessments, there was a significant decline in the dementia group in orientation (z=2.4, P=0.02),
Experienced an increase of MMSE scores of 26.8 (11006) 2.4. Eighteen (16%; 95% CI, 10 to 22) who had improvement scores except for language expression.

### TABLE 2. Differences in Cognitive Profile Between Initial Assessments and Follow-Up in People Who Developed Dementia

<table>
<thead>
<tr>
<th></th>
<th>Dementia Cases</th>
<th>Significant Change in Dementia Group Between 3 and 15 mo After Stroke,* P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>9.4 (0.5)</td>
<td>8.0 (1.2)</td>
</tr>
<tr>
<td>Language comprehension</td>
<td>8.1 (1.1)</td>
<td>7.9 (0.9)</td>
</tr>
<tr>
<td>Language expression†</td>
<td>14.8 (2.2)</td>
<td>14.0 (2.1)</td>
</tr>
<tr>
<td>Memory total</td>
<td>19.4 (3.7)</td>
<td>16.7 (3.7)</td>
</tr>
<tr>
<td>Attention</td>
<td>4.8 (2.6)</td>
<td>3.3 (2.3)</td>
</tr>
<tr>
<td>Praxis</td>
<td>9.9 (2.6)</td>
<td>8.2 (3.5)</td>
</tr>
<tr>
<td>Calculation</td>
<td>1.6 (0.5)</td>
<td>1.4 (0.5)</td>
</tr>
<tr>
<td>Abstract thinking</td>
<td>4.7 (2.4)</td>
<td>5.5 (2.3)</td>
</tr>
<tr>
<td>Perception</td>
<td>6.5 (1.1)</td>
<td>6.5 (1.4)</td>
</tr>
<tr>
<td>Executive function</td>
<td>10.8 (3.5)</td>
<td>12.0 (3.7)</td>
</tr>
<tr>
<td>MMSE</td>
<td>25.4 (2.6)</td>
<td>20.7 (3.1)</td>
</tr>
<tr>
<td>CAMCOG total</td>
<td>79.2 (11.9)</td>
<td>71.5 (12.0)</td>
</tr>
<tr>
<td>Boston Naming Test</td>
<td>44.3 (8.9)</td>
<td>42.0 (11.5)</td>
</tr>
<tr>
<td>FAS</td>
<td>17.1 (14.3)</td>
<td>15.4 (11.9)</td>
</tr>
</tbody>
</table>

Values in parentheses are SD.

*Wilcoxon signed-rank test. †Mann-Whitney tests did not indicate any significant baseline differences between dementia and stable cases in baseline scores except for language expression (P=0.01) and number vigilance mean (P=0.032).

### TABLE 3. Comparison Between Initial Assessments and Follow-Up Among Patients With Cognitive Improvement

<table>
<thead>
<tr>
<th></th>
<th>Improvers</th>
<th>Significant Change in Improvers Group Between 3 and 15 mo After Stroke,† P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>8.8 (1.2)</td>
<td>9.5 (1.2)</td>
</tr>
<tr>
<td>Language comprehension</td>
<td>8.1 (1.0)</td>
<td>7.8 (1.7)</td>
</tr>
<tr>
<td>Language expression</td>
<td>15.5 (3.0)</td>
<td>17.1 (1.6)</td>
</tr>
<tr>
<td>Memory total</td>
<td>20.3 (5.5)</td>
<td>21.3 (3.7)</td>
</tr>
<tr>
<td>Attention†</td>
<td>4.9 (1.7)</td>
<td>5.9 (1.6)</td>
</tr>
<tr>
<td>Praxis</td>
<td>10.3 (1.5)</td>
<td>10.3 (1.7)</td>
</tr>
<tr>
<td>Calculation</td>
<td>1.7 (0.5)</td>
<td>1.7 (0.5)</td>
</tr>
<tr>
<td>Abstract thinking</td>
<td>3.5 (2.3)</td>
<td>5.7 (2.1)</td>
</tr>
<tr>
<td>Perception</td>
<td>7.0 (1.4)</td>
<td>6.3 (1.6)</td>
</tr>
<tr>
<td>Executive function</td>
<td>10.8 (3.9)</td>
<td>14.22 (4.7)</td>
</tr>
<tr>
<td>MMSE</td>
<td>23.1 (2.5)</td>
<td>26.9 (2.8)</td>
</tr>
<tr>
<td>CAMCOG total†</td>
<td>79.1 (9.3)</td>
<td>85.7 (7.5)</td>
</tr>
<tr>
<td>Boston Naming Test</td>
<td>45.9 (6.8)</td>
<td>46.7 (9.4)</td>
</tr>
<tr>
<td>FAS</td>
<td>21.6 (11.1)</td>
<td>23.2 (12.7)</td>
</tr>
</tbody>
</table>

Values in parentheses are SD.

*Wilcoxon signed-rank test. †Mann-Whitney tests did not indicate any significant differences between improvers and stable cases in initial scores except for attention (P=0.02), orientation (P=0.03), and total CAMCOG (P=0.04).

Learning memory (z=2.2, P=0.027), CAMCOG memory score (z=2.4, P=0.02), and MMSE (z=2.9, P=0.004; Table 2).

**Improvement**

Conversely, 57 patients (50%; 95% CI, 32 to 68) experienced an increase in MMSE (mean, 2.2 points: 24.6±2.6 to 26.8±2.4). Eighteen (16%; 95% CI, 10 to 22) who had MMSE scores of ≤27 at the time of the baseline evaluation experienced an increase of >2 points (this was also equivalent to an improvement of >1 SD of the initial score) in MMSE, with a 6.6-point increase in the total CAMCOG (Wilcoxon z=3.5, P<0.0001) between the 3- and 15-month assessments and significant increases in scores for orientation, language expression, abstract thinking, memory total, attention, perception, and executive performance (Table 3). The remaining 39 patients (34%; 95% CI, 22 to 46) experienced more modest MMSE improvements of 1 or 2 points (6 of these scored >27 in the MMSE at baseline).

There was no difference in baseline fluctuating cognition, as determined by CRT SD (improvers versus stable cases, z=0.37, P=0.72; improvers versus decliners, z=0.38, P=0.70), or mood, as determined by Cornell (improvers versus stable cases, z=0.54, P=0.59; improvers versus decliners, z=0.26, P=0.80); hence, mood disorder and delirium at the time of the baseline assessment are unlikely to be the explanations for improvement.

People with diabetes were significantly less likely to be classified as improvers (Fisher’s exact test, P<0.001; Table 1).

**People Who Remained Stable**

Eighty-seven patients (76%; 95% CI, 62 to 90) neither developed dementia nor improved by >2 points on the MMSE and hence were considered to remain stable. Both overall (CRT: z=2.3, P=0.02; total CAMCOG: z=2.9, P=0.003; abstract thinking: z=4.3, P<0.0001; executive function: z=4.6, P<0.0001; FAS: z=3.4, P=0.001) and in the subgroup of people with baseline MMSE scores ≤27 (MMSE: z=2.7, P=0.007; executive function: z=3.0, P<0.0003; abstract thinking: z=3.5, P<0.0001; calculation: z=2.3, P=0.02; FAS: z=2.0 P=0.049), there were a number of areas of cognitive improvement in the patients defined as remaining stable, with a profile similar to that seen in the improvers group (Table 4).

**Predictive Value of Baseline Cognitive Assessment for Subsequent Dementia**

The only neuropsychological tests that differed at baseline between those who developed dementia and those who remained stable were expressive language performance (z=2.5, P=0.01) and number vigilance mean reaction time (z=2.2, P=0.03). There were no significant differences in the other neuropsychological evaluations, including memory and executive performance, or in depression scores.

**Criteria for Early Cognitive Impairment**

The proportion of stroke patients meeting criteria for early cognitive impairment at 3 months varied from 17% to 66%, depending on the criteria used (MCI: 17%; 95% CI, 11 to 23; AACD: 30%; 95% CI, 20 to 40; vascular CIND: 35%; 95% CI, 22 to 48; AADC: 66%; 95% CI, 42 to 90; AADC; Table 5). The criteria that performed best for predicting incident dementia were those for AACD based on the CRT task—10.5% versus 5%, although the potential utility was extremely limited (sensitivity, 95%; positive predictive value, 46.7; specificity, 54%; negative predictive value, 99%) because of the rarity of dementia.
TABLE 4. Comparison Between Initial Assessments and Follow-Up in People Who Remained Stable

<table>
<thead>
<tr>
<th></th>
<th>Stable Cases</th>
<th>Significant Change in Improvers Group Between 3 and 15 mo After Stroke,[^*]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>1 y</td>
</tr>
<tr>
<td>Orientation</td>
<td>9.4 (0.9)</td>
<td>9.4 (0.8)</td>
</tr>
<tr>
<td>Language comprehension</td>
<td>8.4 (0.7)</td>
<td>8.3 (1.1)</td>
</tr>
<tr>
<td>Language expression</td>
<td>16.8 (2.0)</td>
<td>17.0 (1.8)</td>
</tr>
<tr>
<td>Memory total</td>
<td>20.8 (3.0)</td>
<td>21.2 (3.2)</td>
</tr>
<tr>
<td>Attention</td>
<td>5.9 (1.5)</td>
<td>6.0 (1.4)</td>
</tr>
<tr>
<td>Praxis</td>
<td>10.2 (1.5)</td>
<td>10.2 (1.5)</td>
</tr>
<tr>
<td>Calculation</td>
<td>1.7 (0.5)</td>
<td>1.8 (0.4)</td>
</tr>
<tr>
<td>Abstract thinking</td>
<td>3.9 (2.6)</td>
<td>5.4 (2.1)</td>
</tr>
<tr>
<td>Perception</td>
<td>6.7 (1.5)</td>
<td>6.7 (1.4)</td>
</tr>
<tr>
<td>Executive function</td>
<td>12.4 (4.7)</td>
<td>15.2 (4.6)</td>
</tr>
<tr>
<td>MMSE</td>
<td>26.5 (2.5)</td>
<td>26.7 (2.4)</td>
</tr>
<tr>
<td>CAMCOG total</td>
<td>84.0 (8.4)</td>
<td>86.0 (7.9)</td>
</tr>
<tr>
<td>Boston Naming Test</td>
<td>47.8 (7.2)</td>
<td>48.5 (7.5)</td>
</tr>
<tr>
<td>FAS</td>
<td>22.3 (11.1)</td>
<td>25.4 (12.1)</td>
</tr>
</tbody>
</table>

Values in parentheses are SD.

[^*]Wilcoxon signed-rank tests.

35%; specificity, 9%) and none of the criteria significantly predicted the development of dementia (Table 5).

In contrast to those who developed dementia, 14% to 20% of patients meeting criteria for early cognitive impairment improved, no longer meeting criteria at the follow-up evaluation (16% MCI, 20% vascular CIND, 14% AACD spatial working memory, 17% AACD-CRT).

Discussion

The present study is the first longitudinal evaluation to examine in detail the profile of changes in cognitive impairments specifically found in older stroke patients without dementia. Nine percent of patients developed incident dementia over the 1-year follow-up period, but, importantly, 50% of patients experienced some improvement in cognition, with 16% experiencing an improvement of >2 points on the MMSE.

Decline in Cognitive Function

More than 30% of people experienced some decline in cognitive function, with 9% developing incident dementia. The proportion of people experiencing a significant decline in cognitive function between 3 and 15 months after stroke is very similar to the proportion of people with MCI “converting” to Alzheimer’s disease in memory clinic studies[^32] and is substantially higher than the 1% to 2% per year reported in the community.[^33]

In a 5-year follow-up of a broad group of patients meeting criteria for vascular CIND from the Canadian Study for Health and Aging, a 5-year incidence of dementia of 44% was reported[^34] an annual incidence similar to that in the present study. The high frequency of delayed incident dementia emphasizes the importance of progressive cognitive decline and the need for secondary prevention studies.

Improvement in Cognition

A large proportion of patients (50%) experienced improvement in cognition, with 16% experiencing >2-point improvement on the MMSE. The present study supports the conclusions of previous studies of younger stroke patients that delayed improvements do occur[^8,9] and indicates that they are even more frequent in older stroke patients. Understanding the mechanisms should lead to novel interventions, with additional important implications for rehabilitation, driving, and planning care needs. There are also key implications for intervention studies because it may be inappropriate to begin dementia pharmacotherapy in people with a high likelihood of experiencing spontaneous improvement. People with diabetes were significantly less likely to experience improvement. Although the present study is not powered to examine risk factors, this preliminary observation is consistent with previous work in younger stroke patients.[^8]

Many patients in the stable group also experienced a similar profile of cognitive improvement, indicating a continuum between stability and improvement and suggesting that cognitive improvement is the usual outcome for people who do not develop dementia. This is a fundamental change in emphasis because it indicates that although cognitive decline is frequent, it is not the usual outcome. We would therefore hypothesize that cognitive function improves unless individuals have concurrent cerebrovascular or neurodegenerative disease or develop further cerebral insults. This is consistent with observations that conditions linked to small-vessel disease are associated with lack of improvement.[^8] Further mechanistic studies are important. In particular, factors that govern neuronal plasticity after a stroke may be of particular interest with the potential to lead to new therapeutic strategies.

TABLE 5. Frequencies of Elderly Stroke Patients Meeting Criteria for MCI, Vascular CIND, and AACD

<table>
<thead>
<tr>
<th>Threshold (SD) From Previously Published Elderly Control Group</th>
<th>Patients Meeting Specific Sets of Criteria for Early Cognitive Deficits at 3 and 12 mo With DSM IV Dementia</th>
<th>Stroke Patients With Early Cognitive Impairment at 3 and 12 mo With DSM IV Dementia at 15 and 12 mo, n (%)</th>
<th>Stroke Patients Without Early Cognitive Impairment at 3 and 12 mo With DSM IV Dementia at 15 and 12 mo, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory CAMCOG memory &lt;17.6</td>
<td>MCI, 19 (17)</td>
<td>2 (10.5)</td>
<td>8 (8)</td>
</tr>
<tr>
<td>Global Cognition CAMCOG total &lt;80</td>
<td>CIND, 40 (35)</td>
<td>4 (10)</td>
<td>6 (8)</td>
</tr>
<tr>
<td>CRT &gt;585 ms</td>
<td>AACD-CRT, 76 (66)</td>
<td>8 (10.5)</td>
<td>2 (5)</td>
</tr>
<tr>
<td>Spatial Working Memory (sensitivity)</td>
<td>AACD-SPW, 35 (30)</td>
<td>4 (11)</td>
<td>6 (8)</td>
</tr>
</tbody>
</table>

n = 115.

Chi squared tests indicate that presence of MCI, CIND, AACD-CRT, AACD-SPW at 3 months does not predict Dementia at 15 months (p = 0.76, 0.72, 0.33 and 0.51 respectively).
Criteria for Early Cognitive Impairment in People With Cerebrovascular Disease

None of the widely used criteria for early cognitive impairment, including MCI, vascular CIND, and AACD, predicted people at higher risk of progressive cognitive decline. In addition, on the basis of a detailed neuropsychological evaluation, only greater impairment of expressive language performance and attention (number vigilance) was significantly associated with a higher risk of progressive cognitive decline. The association with impairment of language expression is consistent with a report from the Canadian Study for Health and Aging, which focused on a broader group of patients with vascular CIND.34 Initial memory performance was associated with subsequent decline in the Canadian study but not the present report. This may be explained by the broader group of vascular CIND patients incorporated into the Canadian study or the different time frame of follow-up, with atrophy becoming more important over a 5-year period.

It is imperative to try to improve the early identification of people at risk of delayed poststroke dementia to enable interventions aimed at secondary prevention. Perhaps criteria need to incorporate clinical features, putative risk factors, MRI characteristics, and relevant genetic polymorphisms, in addition to neuropsychological performance. It is important, however, that such criteria are developed from a strong evidence base and that such criteria are appropriately validated before large clinical trials are begun.

Conclusions

Delayed dementia is frequent after stroke. However, delayed improvements in cognition are also frequent, and mechanistic studies facilitating understanding the underlying processes will offer new therapeutic opportunities.

References

Subjects ≥75 years of age are the fastest-growing segment of the population in Western countries. They currently represent 6.0% of the population in the United States and 6.6% in Europe and will become, by the year 2030, >9% and 12%, respectively.¹

This age group has the highest risk of cognitive impairment and dementia, and stroke is among the factors that account for this risk.² Previous studies have found that ≈30% of stroke survivors ≥75 years of age suffer from dementia, a percentage that is considerably higher than in younger stroke patients. In this issue of Stroke, Ballard et al³ present a longitudinal study of a small group of stroke patients ≥75 years of age who underwent a detailed neuropsychological evaluation 3 months after an ischemic stroke and again 1 year later to investigate delayed changes in cognitive functions after stroke and to verify whether commonly used criteria for early cognitive impairment, ie, mild cognitive impairment, aging-associated cognitive decline, and vascular cognitive impairment, no dementia (vascular CIND), were able to predict cognitive deterioration. The proportion of patients experiencing a decline in cognitive functions was 30%, with 9% developing dementia. However, cognitive improvement was observed in ≈50% of the patients, and 16% showed an increase of >2 points in the Mini Mental State Examination score. This study adds to the previous literature because it demonstrates that none of the proposed criteria for identifying subjects with cognitive impairment at high risk for dementia, including vascular CIND, can predict which stroke patients will develop dementia. This finding, which needs to be replicated in other samples, confirms the existence of an important knowledge gap in this area: the criteria for cognitive impairment in stroke patients need to be refined considering the peculiar characteristics of this population.⁴ Identification of the patients who have a high probability of experiencing cognitive decline and developing dementia after stroke would be of paramount importance in planning intervention trials aimed at preventing these dreadful outcomes, but this is not going to be an easy task. First, cognitive changes after stroke have a highly dynamic course in the months after the acute event, as confirmed by the study of Ballard et al. Moreover, poststroke dementia patients are a heterogeneous group, not only because of the different features of the stroke but also because a considerable percentage has preexisting cognitive impairment.⁵ In view of the complexity of the mechanisms likely to be responsible for poststroke dementia, several other factors besides neuropsychological performance should be taken into account. Sociodemographic factors (eg, older age, low education attainment), prestroke cognitive impairment, stroke features (severity, location, recurrence), neuroradiological features (extent of white matter lesions, medial temporal lobe atrophy), and comorbidities (eg, diabetes mellitus, diseases inducing hypoxia or ischemia such as myocardial infarction, atrial fibrillation, and pneumonia) have been associated in some studies with a higher probability of dementia after stroke.⁶⁻² Longitudinal studies are needed with serial assessment of clinical, neuroradiological, neuropsychological, and possibly biological data, starting immediately after the ischemic stroke. This study design would allow detection of the occurrence of delirium, a condition that might be a marker, even in subjects without preexisting cognitive impairment, of an increased risk of dementia,⁸ and evaluation of the long-term effects of acute management of ischemic stroke on cognitive functions.

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References
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