Predictors of Survival Among Elders Suffering Strokes in Taiwan
Observation From a Nationally Representative Sample
Shu-Li Wang, PhD; Wen-Harn Pan, PhD; Meng-Chih Lee, MD, PhD, MPH; Shu-Ping Cheng, BSc; Ming-Cheng Chang, PhD

Background and Purpose—Cerebrovascular disease was the leading cause of death in Taiwan from 1963 to 1982. Deaths due to stroke now rank second only to cancer, with more deaths resulting from strokes than from any other single pathology. It is important to understand stroke prognosis among elderly stroke survivors, with respect to survival and attendant predictive factors, because aged population in Taiwan is growing rapidly. The aim of the present study was to discern factors affecting survival in stroke patients from a nationally representative elderly sample.

Methods—A total of 99 stroke survivors, from a representative national sample of elders aged $\geq 65$ years on December 31, 1988, whose strokes occurred in the period 1989–1993, were followed for mortality until July 1, 1995. Personal data were gathered through home interviews conducted by well-trained community nurses, and mortality data were obtained from the national census office by using identification card numbers. Cox proportional hazards regression analysis and the stepwise technique were used to search for important prognostic factors of survival.

Results—Women experienced a higher mortality rate (139.8 per 1000 person-years) than men (126.4 per 1000 person-years), as age-adjusted for World Health Organization world-population figures. Stroke patients who received continuous treatment for diabetes experienced mortality risks similar to those of patients without diabetes and much lower risks than those with discontinuous diabetes treatment. Cognitive impairment was also an independent predictor of survival (relative risk 2.69, $P<0.05$). In addition, patients with both cognitive and mobility impairments had a 2- to 3-fold greater risk of mortality than those with only a single abnormality.

Conclusions—This first report on the various prognostic factors related to survival of elderly stroke patients in Taiwan’s Chinese population emphasized the benefit of continuous diabetes treatment in improving survival chances. These stroke patients should also be monitored for cognitive and mobility impairments and undergo rehabilitation. (*Stroke*. 2000;31:2354-2360.)

Key Words: elderly ■ epidemiology ■ stroke outcome ■ survival
survival. Because none of these studies were targeted to the elderly, disabilities such as cognitive impairment or depression were not investigated. In addition, modifiable factors related to survival were also proposed. A community-based study of the elderly, which used self-reporting to identify stroke cases, showed increased blood glucose, cognitive impairment, and other subclinical diseases to be important predictors of survival. Nonetheless, to the best of our knowledge, no such data on survival predictors are available for Chinese populations. The aim of the present study was to examine prognostic factors of survival for elders suffering strokes, with specific focus on depression and other subclinical diseases to be important predictors of survival. 

Subjects and Methods

Study Population

The studied Taiwan population, originally derived from a comparative study of the elderly in Asian countries (Philippines, Singapore, Taiwan, and Thailand), was supported by a United States National Institute on Aging research grant. Details of the sampling process were published previously. Briefly, this was a 3-stage, equal-probability sample. In the first stage, 56 sample townships were randomly drawn from a total of 331 non-aboriginal townships. The sample was stratified by 3 administrative levels, 3 education levels, and 3 overall fertility rates. In the second stage, lins (smallest governmental administration unit in Taiwan, with large variation in population size [hundreds, on average]) in sampled townships were selected by systematic random sampling by using probabilities proportional to their population sizes. In the third stage, 2 eligible respondents, defined as individuals aged ≥60 years as of December 31, 1988, were selected by systematic random sampling from each selected lin. Respondents’ names and addresses were obtained from local population census offices. Selected respondents who no longer resided at the addresses listed for them within selected lins were interviewed at their new addresses, wherever in Taiwan they happened to be. As shown in Figure 1, a total of 4049 persons were successfully interviewed in 1989. They were followed up for recent stroke occurrence until 1993. Vital statistics from the 1993 interviews were included in the present study. Thus, a total of 98 stroke patients formed the study population. These were tracked for survival until July 31, 1995. Twenty-one percent of the men and 28% of the women died during the 2-year follow-up period. Survival rates for those sustaining strokes and those remaining stroke-free were compared. Among stroke patients, prognostic factors related to survival were evaluated.

Data Collection and Various Scales

Baseline data collected in 1989 and follow-up data collected in 1993 were derived from home interviews by well-trained community nurses. Subjects were asked: “Do you have any of the following illnesses, diseases, or symptoms at the present time?” The disease list included stroke. Prognostic factors recorded in 1993 that served as predictors of survival status in 1995 included demographic data, disease and treatment histories, lifestyle, and economic status. The various scales used in the present study included physical functions, cognitive impairment, and depression. The Barthel Index and Karnofsky scale were used to assess physical functions, including activities of daily living (ADL), instrumental activities of daily living (IADL), and mobility impairment. Details of each scale are listed in the Appendix. Disabilities in ADL, IADL, and mobility impairment were defined as being completely incapacitated in 1 or more listed items. Assessment of cognitive impairment was based on the number of questions answered incorrectly. Depression was defined as the number of negative feeling lasting for 5 to 7 days, on average, every week. Two questions designed to elicit positive feelings were coded in opposite ways during analysis. Thus, the total number of expressed negative feelings revealed the degree of depression.

Follow-Up

A total of 99 subjects who sustained strokes in the period 1989–1993 were tracked for survival until July 31, 1995. To guarantee successful follow-up, telephone interviews were conducted in 1991. Life/death status data and death certificates were obtained from the local population census offices, and dates of death were recorded for survival analyses. A 99% follow-up rate was achieved, with only 1 subject lost to follow-up.

Statistical Methods

A direct method of age standardization was used for various mortality rates in stroke patients that included all people aged ≥65 in Taiwan and truncated (≥65) WHO world population as reference populations. An indirect method of age standardization was used to calculate the standardized mortality ratio (SMR) in order to compare the mortality rates in our subject constituency with those of the general population aged ≥65 years in Taiwan. Assessment scores for the various scales were first grouped into 3 categories—normal, mild, and severe—to facilitate statistical analyses and presentation. For ADL and mobility impairment, 1 to 3 items of disability were combined as “mild” impairment, and 4 to 6 items were grouped into the “severe” category. Zero items were considered “normal.” Similar grouping was applied to IADL (0, 1–4, and 5–8), cognitive impairment (0, 1–5, and 6–10), and depression (0, 1–5, and 6–11). Survival curves showed markedly lower survival rates for subjects with severe disabilities compared with the other 2 groups. Thus, in regression analyses, disability was treated as a dichotomous variable, with the normal and mild categories as value 0 and the severe category as value 1.
Kaplan-Meier survival curves were drawn for the various groups. A Cox proportional hazard regression analysis was used to estimate relative risks for univariate and multivariate analyses. In multivariate analysis, a stepwise technique was used to model survival.

**Results**

**Mortality Rates and Comparisons Between Deceased and Living Patients**

As shown in Figure 1, the present study population consisted of 99 stroke patients whose strokes occurred during the 1989–1993 follow-up period. The present results were based on observation of these stroke subjects. Approximately 1 in 4 of the patients died during the 1993–1995 follow-up.

Focusing on the 99 patients suffering stroke, Table 1 shows all-cause mortality rates for stroke patients between 1993 and 1995. Among men, the rate was higher in the ≥75 years age group than in the 65 to 74 years age group. However, among women the rate was higher in the 65 to 74 years age group. The overall age-adjusted mortality rate was 120.48 per 1000 person-years using Taiwan’s population as a reference, and 121.25 using the WHO world population as a reference. Thus, the women we studied appeared to experience higher mortality rates than men, but the differences were not statistically significant. Stroke patients had a 5.37-fold greater risk of dying than the general population of Taiwan aged ≥65 years.

Table 2 shows the distribution of characteristics among the 23 deceased patients compared with those among the 75 survivors. We found that discontinuous diabetes treatment signified a relative risk (RR) as high as 9.78 (P=0.001) compared with absence of diabetes or continuously treated diabetes. Each of the functional scales, except those for depression and IADL, is associated with a significantly increased risk of death. Patients who answered 6 to 10 items incorrectly during cognitive impairment testing experienced a 4.18-fold (P=0.002) greater risk of death compared with those who gave 0 to 5 incorrect answers. Being bedridden showed borderline significance in predicting death, with an RR of 2.65 (P=0.055). Accordingly, we investigated these prognostic factors further by regression analyses. We found that lower-income patients had an RR of 2.26, but these findings were not statistically significant.

We also calculated age-adjusted mortality rates according to diabetes and cognitive impairment. Patients with diabetes were divided into those who received and did not receive treatment. We found that stroke patients who received continuous treatment for diabetes (183.5 per 1000 person-years) experienced mortality risks similar to those of patients without diabetes (92.5) and much lower risks than those of patients with untreated diabetes (1601.2). Age-adjusted mortality rates increased consistently and roughly linearly with increasing grading on the cognitive impairment scale: 0, 71.1, 153.2, to 224.7 per 1000 person-years for those with 0, 1 to 3, 4 to 6, and 7 to 10 items of cognitive impairment, respectively.

**Survival Analysis Outcome**

Figure 2 shows that survival rates were consistently lower for stroke patients than for those who had not sustained strokes. The second-year survival rates are shown according to the occurrence of stroke by sex. Women had slightly higher survival rates than men when neither had sustained strokes. When both had suffered strokes, women consistently experienced lower survival rates than men, reaching a difference of 9.7% in survival rates by the second year of follow-up.

As shown in Figure 3, subjects who had serious mobility impairment had lower survival rates than those with less-severe mobility impairment. Survival curves showed markedly lower survival rates in subjects with 4 to 6 items of mobility impairment compared with the other 2 groups. This association illustrates a typical survival curve pattern for the various scales with the exception of depression, for which the association was less clear.

Table 3, generated by Cox stepwise regression analysis, shows that discontinuous diabetes treatment and cognitive impairment are significant predictors of survival when adjusted for age (discontinuous diabetes treatment: RR 9.56, \( P<0.01 \); cognitive impairment: RR 2.69, \( P<0.05 \)). Mobility impairment was also found to be a noteworthy predictor, with an RR of 1.71 when included in the model (data not shown), but it did not achieve statistical significance (\( P=0.35 \)). Because cognitive and mobility impairments are correlated, further analysis of the 2 predictors showed an additive effect on survival.

<table>
<thead>
<tr>
<th>Age in 1993</th>
<th>Total (95% CI)</th>
<th>Men (n/N)</th>
<th>Women (n/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>65–74 y</td>
<td>116.62 (55.5–177.7)</td>
<td>91.85 (7/39)</td>
<td>159.69 (7/23)</td>
</tr>
<tr>
<td>≥75 y</td>
<td>129.48 (45.2–213.8)</td>
<td>136.98 (6/23)</td>
<td>123.05 (3/13)</td>
</tr>
<tr>
<td>Total</td>
<td>119.87 (69.9–169.9)</td>
<td>105.13 (13/62)</td>
<td>146.59 (10/36)</td>
</tr>
<tr>
<td>Std Rate (Taiwan)*</td>
<td>120.48 (71.4–169.6)</td>
<td>104.04</td>
<td>147.23</td>
</tr>
<tr>
<td>Std Rate (WHO)**</td>
<td>121.25 (72.0–170.5)</td>
<td>106.74</td>
<td>149.06</td>
</tr>
</tbody>
</table>

$^*_{\text{Standardized mortality rate by direct method using Taiwan’s total ≥65-year population as the reference population.}}$

$^\dagger_{\text{Standardized mortality rate by direct method using the WHO world ≥65-year population as the reference population.}}$

$^\ddagger_{\text{Standardized mortality ratio by indirect method using Taiwan’s total ≥65-year population as the reference population.}}$
Mobility impairment was a significant predictor of survival in univariate analysis, with an RR of 4.01, but became insignificant in multivariate analysis. We did further analyses and found that the mortality risk was as high as 346.2 person-years in subjects with both serious cognitive and mobility impairments compared with those having only serious cognitive impairment (117.59) or only mobility impairment (156.16). Those without serious cognitive or mobility impairments had the lowest rate, 41.4 per 1000 person-years.

TABLE 2. Distribution of Characteristics According to Life/Death Status and Relative Risk by Univariate Analysis (Cox's Proportional Hazard Regression Model) in Stroke Patients ≥65 Years in the Community

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Deceased, %</th>
<th>Alive, %</th>
<th>RR*</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>74.30</td>
<td>71.99</td>
<td>1.06 (0.99–1.13)</td>
<td>0.088</td>
</tr>
<tr>
<td>Female sex (Y/N)*</td>
<td>43.48</td>
<td>34.67</td>
<td>1.37 (0.60–3.12)</td>
<td>0.455</td>
</tr>
<tr>
<td>Discontinuous diabetes treatment (Y/N)†</td>
<td>33.33</td>
<td>0.00</td>
<td>9.78 (2.73–35.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Bedridden (Y/N)</td>
<td>21.74</td>
<td>6.67</td>
<td>2.65 (0.98–7.16)</td>
<td>0.055</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NT $10 000/mo (less/more)‡</td>
<td>80.00</td>
<td>60.81</td>
<td>2.26 (0.76–6.74)</td>
<td>0.144</td>
</tr>
</tbody>
</table>

Physical function scales

ADL

<table>
<thead>
<tr>
<th>Items</th>
<th>Deceased, %</th>
<th>Alive, %</th>
<th>RR* (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>69.57</td>
<td>90.67</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>4–6</td>
<td>30.43</td>
<td>9.33</td>
<td>2.99 (1.23–7.26)</td>
<td>0.016</td>
</tr>
</tbody>
</table>

IADL

<table>
<thead>
<tr>
<th>Items</th>
<th>Deceased, %</th>
<th>Alive, %</th>
<th>RR* (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>52.17</td>
<td>68.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>5–8</td>
<td>47.83</td>
<td>32.00</td>
<td>1.79 (0.79–4.07)</td>
<td>0.164</td>
</tr>
</tbody>
</table>

Mobility impairment

<table>
<thead>
<tr>
<th>Items</th>
<th>Deceased, %</th>
<th>Alive, %</th>
<th>RR* (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>34.78</td>
<td>73.33</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>4–6</td>
<td>65.22</td>
<td>26.67</td>
<td>4.01 (1.70–9.49)</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Cognitive impairment

<table>
<thead>
<tr>
<th>Items</th>
<th>Deceased, %</th>
<th>Alive, %</th>
<th>RR* (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–5</td>
<td>38.10</td>
<td>75.68</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>6–10</td>
<td>61.90</td>
<td>24.32</td>
<td>4.18 (1.72–10.15)</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Depression

<table>
<thead>
<tr>
<th>Items</th>
<th>Deceased, %</th>
<th>Alive, %</th>
<th>RR* (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–5</td>
<td>86.36</td>
<td>92.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>6–11</td>
<td>13.64</td>
<td>8.00</td>
<td>1.25 (0.68–2.54)</td>
<td>0.188</td>
</tr>
</tbody>
</table>

*Relative risk for relative mortality of women vs men.
†Discontinuous DM treatment vs those with treatment or without diabetes.
‡Income less than NT $10 000 vs those with more; NT $1 equals approximately US $0.03.
§RR of mortality for those with 4–6 disabilities vs those with 0–3 disabilities.

Figure 2. Survival curves for all subjects according to the presence of stroke by sex.
Discussion

The present study demonstrates that elderly stroke patients in the community experienced a studied 5.37-fold greater risk of mortality than the general population. Among stroke patients, women experienced much lower survival rates than men during the follow-up period. The most significant predictors of survival were discontinuous diabetes treatment and cognitive and mobility impairments.

Stroke patients with continuous diabetes treatment experienced mortality risks similar to those without diabetes, and much lower risks than those with discontinuous diabetes treatment. Discontinuous diabetes treatment was also found to have the highest RR for mortality at 9.56 ($P < 0.01$), independent of age and cognitive impairment. Studies of stroke-survival prognoses among white Americans and Canadians showed diabetes to be a significant predictor of mortality independent of heart diseases. Similarly, analysis of stroke registry data in Sweden showed that the presence of diabetes was a significant predictor of both mortality and recurrence in stroke patients during the period 1989–1992. However, whether subjects had continuous treatment for diabetes was not considered in these 3 studies. Our results emphasize the benefit of continuous diabetes treatment in improving survival chances among stroke elderly. We further investigated these deceased stroke patients without continuous diabetes treatment through review of their death certificates and medical records and discussions with their clinicians. Diabetes was even not mentioned on their death certificates. Reviews of the medical records showed that blood glucose level was not measured or monitored in 1 patient. Diabetes was not under control in 2 patients because the cost was relatively high during that time, when the national health insurance was not available. The other contributory reasons may result from the lack of awareness of blood glucose control in these patients (personal communications with the subjects' clinical doctors). It is pointed out that better surveillance of diabetes followed by proper treatment would be crucial to decrease mortality, particularly in women, from our survival observations.

Cognitive impairment was also found to be an important and independently significant predictor of survival, with an RR of 4.18 ($P < 0.01$) in univariate analysis and 2.69 ($P < 0.05$) in multivariate analysis, when adjusted for age and discontinuous diabetes treatment. Mortality rates also increased consistently with severity of the impairment. Similar results were reported for clinic-based ischemic stroke patients aged ≥60 years, in which dementia was the most significant predictor of 4.5-year survival, with an RR of 3.11 (95% CI 1.79 to 5.41). Cognitive impairment, as assessed by the 10 questions used in the present study, showed a high degree of predictive accuracy in determining severity of impairment. We recommend using this simplified mental status test, which can be widely applied, in community settings. Cognitive impairment is generally considered a non-modifiable factor. However, it has been suggested that intervention in high blood pressure may prevent dementia in elderly men. In addition, a 3-year follow-up study of a population-based stroke registry in New Zealand showed that patients who lost consciousness had the lowest survival rates, especially when the strokes occurred in institutions. Though cognitive impairment, like other scales, is an appropriate measurement of stroke severity, its value in predicting survival helps clinicians and health planners assess needs.

Mobility impairment was also found to be an important predictor of survival, with an RR of 4.01 ($P < 0.002$) in univariate analysis. In multivariate analysis it became insignificant. Further analysis demonstrated an additive effect with cognitive impairment. Mortality totaled 346.22 per 1000 person-years in those with both severe mobility and cognitive impairments. A population-based cohort study of the elderly showed that physical functioning, as assessed by ADL, together with cognitive impairment predicted the outcomes of

![Figure 3. Survival curves for stroke patients with reported mobility impairment of 0, 1–3, and 4–6 items.](http://stroke.ahajournals.org/)

### Table 3. Stepwise Multivariate Analysis of Survival Predictors With Cox's Proportional Hazard Regression Model in Stroke Patients ≥65 Years in the Community

<table>
<thead>
<tr>
<th>Variable</th>
<th>RR</th>
<th>95% CI of RR</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discontinuous diabetes treatment</td>
<td>9.56</td>
<td>2.47–37.04</td>
<td>0.0011</td>
</tr>
<tr>
<td>Cognitive impairment (6–10/0–5 items)</td>
<td>2.69</td>
<td>1.04–6.96</td>
<td>0.0410</td>
</tr>
<tr>
<td>Age</td>
<td>1.07</td>
<td>0.987–1.16</td>
<td>0.1015</td>
</tr>
</tbody>
</table>

Final one generated by Cox's model.

*RR of mortality for 6–10 wrong answers compared with 0–5 wrong answers.
strokes. Previous findings for a Chinese population showed that physical functions were related to the prevalence of depression in stroke survivors, which may imply that improvements in physical functioning may also reduce the severity of depression.

Regarding sex differences, stroke-free women had slightly higher survival rates than men. However, among stroke patients, we found that women experienced lower survival rates than men, with a difference of 9.7% by the second year of follow-up. Because observation showed that the distribution of stroke type between sexes in Taiwan was very similar, the reason for this survival difference between the sexes maybe result from the difference in risk-factor distribution. It is found that women (5.6%) had a higher rate of discontinuous diabetes treatment than men (3.2%), and this may be the reason for their higher mortality rates. In addition, we found that female stroke patients tend to have slightly more items of ADL and/or morbility impairment than male stroke patients (data not shown).

Disease information obtained from self-reports may underestimate the prevalence of disease, particularly in those without apparent clinical symptoms. However, stroke patients usually have acute symptoms and need team care from neurologists, physiotherapists, and nutritionists, and others. Thus, it is unlikely that stroke patients remain unaware of disease very long. A previous study showed a sensitivity of 95% and a specificity of 96% for the single question, “Have you ever had a stroke?” Stroke types without apparent symptoms, such as transient strokes and so-called silent strokes or minor strokes, were not considered in the present study.

In summary, the present study demonstrated that the nationally representative elderly study group with self-reported strokes experienced a 5.37-fold greater risk of mortality than the general population. Among elderly stroke victims, women experienced lower survival rates than men. This study even pointed out the importance of better surveillance of diabetes followed by proper treatment to decrease the mortality, particularly in women. Cognitive impairment was also found to be an important and independently significant predictor for survival, and mobility impairment was found to have an additive effect on cognitive impairment. Future work will be directed toward evaluating intervention in these associated factors to improve survival. This may include vigorous diabetes monitoring and treatment, rehabilitation to increase physical functioning, and high-blood-pressure control to reduce the risk of cognitive impairment.

**Appendix**

**ADL**

Are you able to:
1. Bathe yourself?
2. Dress and undress yourself?
3. Feed yourself?
4. Stand up and sit down without assistance?
5. Walk around your home?
6. Use the toilet by yourself?

**IADL**

Are you able to:
1. Shop for personal items such as toiletries and medicines?
2. Manage your money, for example, keep track of expenses, and pay bills?
3. Climb 2 to 3 flights of stairs?
4. Take buses or trains by yourself?
5. Walk about 200 to 300 meters?
6. Do heavy housekeeping chores, such as scrubbing floors, cleaning storm ditches, moving furniture, and washing windows?
7. Do light housekeeping, such as mopping floors, washing dishes and disposing of garbage?
8. Use the telephone?

**Mobility Impairment**

Are you able to:
1. Stand up without assistance and stand continuously for about 15 minutes?
2. Crouch?
3. Reach up over your head?
4. Use your fingers to grasp and manipulate objects?
5. Lift or carry something as heavy as 11 to 12 kg (25 pounds) of rice?
6. Run 20 to 30 meters?

**Cognitive Impairment**

Do you know:
1. What your address is?
2. Where you are?
3. The date (day, month, year)?
4. What day it is (day of the week)?
5. Your mother’s maiden name?
6. Who is President now?
7. Who was President previously?
8. How old you are?
9. When you were born (day, month, year)?
10. If you have 20 oranges and eat 3, how many will be left? If you eat 3 more, how many will then be left? (Asked four times in succession: 20 to 3 = ? – 3 = ? – 3 = ? – 3 = ?)

**Depression**

Most or all of the time (5 to 7 days during the week):
1. I did not feel like eating; my appetite was poor.
2. I felt that everything I did was an effort.
3. I slept poorly.
4. I felt very happy.
5. I enjoyed life.
6. I could not “get going.”
7. I felt that people dislike me.
8. I felt depressed.
9. I felt lonely.
10. People were unfriendly to me.
11. I felt sad.

**Acknowledgments**

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**References**

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