Reevaluation of Transient Ischemic Attacks as a Risk Factor for Early Mortality

George Howard, DrPH; Greg W. Evans, MS; Julia L. Thomas, MStat; Jacqueline E. Ryu, PhD; Frederic R. Kahl, MD; and John R. Crouse, MD

The prevailing belief that transient ischemic attack is a risk factor for cardiovascular morbidity and mortality is based primarily on comparisons of survival of patients after transient ischemic attacks to that of an age-, race-, and sex-adjusted general population. Concomitant conditions that carry a high risk of premature mortality or morbidity, such as ischemic heart disease, hypertension, and diabetes, are very prevalent among patients with transient ischemic attacks. Hence, the poor prognosis of such patients may be attributable to these factors rather than their transient ischemic attack per se, which may only serve to bring patients into the medical system. We compared the survival of 336 patients after transient ischemic attack to that of a control group with a similar risk factor profile consisting of 6,710 patients evaluated for cardiac catheterization. Survival estimates, both unadjusted and adjusted for risk factors, did not differ between the two groups. Three-year survival estimates, after adjustment to the mean value of covariates, were 94% for the patients with transient ischemic attacks and 91% for the controls. These results suggest that the transient ischemic attack may not be an independent risk factor for mortality, although it may identify patients already at increased risk from coexisting conditions. (Stroke 1991;22:582-585)

As long ago as the early 1950s, Fisher and Cameron1 expressed a concern that transient ischemic attacks (TIAs) were associated with an increased risk of cerebrovascular events. Such comments initially stressed the increased risk of stroke in TIA patients, but at that time, or indeed today, there were no reliable estimates of the expected incidence of stroke in the general population. Although the stroke rate in the TIA population could be estimated from available data on TIA patients, without knowledge of the stroke rate in the general population, the excess risk of stroke associated with TIA could not be estimated.

Many authors, including ourselves, contrasted the survival of TIA patients to that of an age-, race-, and sex-matched general population.2-8 These reports generally showed the survival of TIA patients to be significantly worse than would be expected in the general population and the cause of death in the TIA population to be most often coronary, rather than cerebrovascular, disease.

However, based on data from the Cooperative Study of Transient Ischemic Attacks9 and our own TIA population,8 TIA patients have a significantly higher prevalence of cerebrovascular and coronary heart disease risk factors, including hypertension, ischemic heart disease, diabetes, cigarette smoking, and previous stroke, than is present in the general population. We have shown previously8 in our TIA cohort that patients with none of these risk factors, and even TIA patients with a single risk factor, fare as well as the age-, race-, and sex-matched general population. In contrast, those TIA patients with two or more of these risk factors have survival estimates that are clearly less than that of the general population. Because most TIA patients have two or more risk factors and because these risk factors so dramatically affect survival, the comparison of the survival of TIA patients to a general population is biased toward showing a relatively poor prognosis for TIA patients. To evaluate the hazard associated with TIA while minimizing the confounding from other risk factors, we first selected a more comparable control group and then removed remaining differences in risk factors through covariate analysis.

Subjects and Methods

We performed a case/control analysis contrasting the survival of TIA patients (cases) with that of a
control group having roughly equivalent risk factor prevalence. We chose the group of patients admitted for cardiac catheterization (CATH) as the control group because their prevalence of major risk factors was similar to that observed in our TIA population.

Since the early 1970s, the Department of Neurology and Section of Cardiology at North Carolina Baptist Hospital has maintained TIA and cardiac catheterization registries that provide historical information regarding risk factors for cardiovascular disease and comorbid conditions. In the case of the TIA registry, a standard questionnaire assessing traditional and nontraditional risk factors for cerebrovascular and coronary heart disease, including smoking behavior and history of hypertension and diabetes, was administered by trained interviewers during hospitalization, with methods detailed elsewhere.8 Data for the catheterization registry were collected using a standard questionnaire assessing similar traditional cardiovascular risk factors. Patient report was used to establish a history of hypertension, diabetes, ischemic heart disease, previous stroke, and cigarette smoking. Unfortunately, definitions differed on smoking, with the TIA patient smoking history being recorded as ever/never (ever=current+past smoking; never=never smoking), whereas the CATH patient smoking history was recorded as current/nonsmoking (current=constant; nonsmoking=past+never). Because smoking is considered an important risk factor, the analysis was performed both with and without smoking as a covariate.

Based on a previously reported algorithm,10 we determined deaths in both cohorts using information supplied from the National Death Index. Patients who matched National Death Index death records were classified as deceased if 1) the death occurred in North Carolina, the social security number (if present on both records) matched on at least eight digits, and the first name matched exactly or both phonetically and on first initial; 2) the death occurred outside of North Carolina, but the social security number matched on all nine digits; or 3) the death occurred in one of nine southeastern states, our records listed no social security number, the day of the month born matched exactly, and the year of the birth matched within 10 years. Vital status was known through the National Death Index and the identical algorithm provided for both groups to avoid bias.

Because the National Death Index began monitoring in 1979, we excluded TIA patients from our previously reported series8 who were admitted before that date, resulting in a TIA study cohort of 338 patients (accrued between 1979 and 1984). Details of their accrual are available in these previous publications. The control group consisted of the 6,872 pa-

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>TIA (n=338)</th>
<th>CATH (n=6,710)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Cigarette smoking*</td>
<td>63</td>
<td>35†</td>
</tr>
<tr>
<td>Ischemic heart disease</td>
<td>30</td>
<td>72‡</td>
</tr>
<tr>
<td>Previous stroke</td>
<td>16</td>
<td>6‡</td>
</tr>
<tr>
<td>Hypertension</td>
<td>54</td>
<td>40†</td>
</tr>
<tr>
<td>Male</td>
<td>46</td>
<td>32‡</td>
</tr>
<tr>
<td>Nonwhite race</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Mean age</td>
<td>63</td>
<td>55‡</td>
</tr>
<tr>
<td>Median age</td>
<td>63</td>
<td>56‡</td>
</tr>
<tr>
<td>Number of major risk factors‡</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

TIA, transient ischemic attack; CATH, cardiac catheterization. *Defined as ever/never for TIA population and current/non-smoking for CATH population. †p<0.001. ‡Major risk factors defined as diabetes, cigarette smoking, ischemic heart disease, previous stroke, and hypertension.

Results

Table 1 shows the prevalence of major risk factors for both groups. The TIA group was, on average, older and had a higher prevalence of hypertension, previous stroke, and cigarette smoking, but a lower prevalence of ischemic heart disease. However, if one
TABLE 2. Proportional Hazard Estimates of the Effect of Significant Demographic and Risk Factors on Survival

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Hazard ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male sex</td>
<td>1.300</td>
<td>0.0003</td>
</tr>
<tr>
<td>Nonwhite race</td>
<td>1.378</td>
<td>0.0114</td>
</tr>
<tr>
<td>Age*</td>
<td>1.634</td>
<td>0.0001</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1.652</td>
<td>0.0001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.271</td>
<td>0.0003</td>
</tr>
<tr>
<td>Cigarette smoking</td>
<td>1.307</td>
<td>0.0001</td>
</tr>
<tr>
<td>Previous stroke</td>
<td>1.638</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

*Effect of age was estimated for a 10-year interval.

The survival of the TIA and CATH groups, unadjusted for differences in risk factor profiles, did not differ significantly (p>0.05). To remove any residual differences in the specific risk factors between the two populations, we developed a proportional hazard model relating demographic and risk factors to survival. In this analysis, we found that sex, race, age, diabetes mellitus, hypertension, cigarette smoking, and previous stroke were jointly associated with survival. In this analysis, we found that sex, race, age, diabetes mellitus, hypertension, cigarette smoking, and previous stroke were jointly associated with survival. In this analysis, we found that sex, race, age, diabetes mellitus, hypertension, cigarette smoking, and previous stroke were jointly associated with survival. In this analysis, we found that sex, race, age, diabetes mellitus, hypertension, cigarette smoking, and previous stroke were jointly associated with survival.

We estimate the associated hazard ratio to be 0.82 (TLA slightly protective), with a 95% confidence interval for the hazard ratio of 0.63–1.07. Figure 1 shows the survival curves, adjusted to the mean level for all covariates. We found similar results (no differences between TIA and CATH) when smoking was omitted as a covariate.

**Discussion**

There was no significant difference between the survival of TIA patients and that of a control group with a similar risk factor profile. This may imply that differences in survival between TIA patients and the general population result from different risk factor prevalences in the two populations, rather than being an independent effect of TIA. It should be expected that the TIA population would have a higher mortality, as well as stroke and myocardial infarction rates, than the general population, given the prevalence of major risk factors in TIA patients. Previous studies may have implicated TIA as a risk factor for mortality because they failed to control for the concomitant disease prevalences. Clearly, the proportion of these concomitant diseases in the general population is far less than that observed in the TIA population.

This study has a number of limitations. First, although the workup of the TIA and CATH patients was similar, it was not performed under the same protocol. It is natural to assume that the neurologists responsible for the CATH patients were more aware of the possibility that TIAs may serve as an independent indicator of excess risk for future nonfatal coronary or cerebrovascular events. Not only does this introduce inconsistent measurement errors between the two groups, but it also allows for some contamination of the control group (CATH) of individuals with undiagnosed TIAs. Nevertheless, we believe this contamination to be minimal, although we have no evidence to support this belief. Also, because we could not examine nonfatal cerebrovascular or myocardial infarction events, we cannot dismiss the possibility that TIAs may serve as an independent indicator of excess risk for future nonfatal coronary or cerebrovascular events. Lastly, while the two populations were similar in the number of risk factors, there were considerable differences in prevalence of specific risk factors. Statistical modeling techniques employed in this report are one of the three well-accepted methods to adjust for such differences. Many of these concerns will be more directly addressed through the prospective study currently gathering risk factor data and following similar TIA and coronary patients.

Most importantly, although these data suggest that TIAs may not represent an independent risk factor for mortality, they still may be viewed as a marker for other significant concurrent diseases. That is, our data support the position that the TIA itself is not a risk factor for early mortality; however, they do not identify a group of patients who have risk factor profiles greatly exceeding those of the general population. As such, an extensive workup of these patients to establish the exact extent of known risk factors and to discover risk factors that are present but previously undocumented appears quite warranted. In addition,
as heart disease continues to be highly prevalent in the TIA population and continues to be the leading cause of death in this population, involvement of cardiologists in this evaluation would appear sound.

Acknowledgments

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References


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