Cessation of Smoking After First-Ever Stroke
A Follow-Up Study

Søren Bak, MD; Søren Hein Sindrup, MD, PhD; Torben Alslev, MD; Ole Kristensen, MD; Kaare Christensen, MD, PhD; David Gaist, MD, PhD

Background and Purpose—Cessation of smoking is widely recommended in patients with stroke to reduce the risk of myocardial infarction and recurrent stroke, but little is known regarding how patients modify their smoking habits after a stroke. We used data from a prospective follow-up study to assess modification of smoking habits and to identify predictors of persistent smoking after first-ever stroke.

Methods—All patients admitted to the only neurology department of Funen County (465 000 inhabitants) with first-ever stroke from August 1, 1999, to January 31, 2001, were prospectively identified. A comprehensive structured interview was completed both during hospitalization and at 6-month follow-up. The interview comprised questions on education, occupation, marital status, lifestyle, concomitant diseases, and functional disability. We estimated the relative risk of persistent smoking at follow-up using unconditional logistic regression.

Results—We identified 734 patients with a first-ever stroke in the study period. One hundred three patients (14%) died in the 6-month period after their admission. A total of 511 patients (81%) who participated in the interview both on admission and at follow-up were included in the present study. Among 198 patients (38.7%) who were current smokers on admission, 43 patients (21.7%) gave up smoking within 6 months of suffering a stroke. Sex, functional status, and sociodemographic characteristics were independently associated with persistent smoking.

Conclusions—Our results suggest that more efficient antismoking counseling is required to reduce the proportion of persistent smokers after stroke. This counseling should take into account the increased risk of persistent smoking in men, patients with no disability, blue-collar workers, and patients living alone. 

Key Words: cigarette smoking ● lifestyle ● stroke prevention

Survivors of acute stroke are at a considerable risk of suffering additional stroke events. Community-based studies indicate that the cumulative risk of recurrent stroke is approximately 13% within the first year and 20% to 40% by 5 years after first-ever stroke.1-4 Furthermore, among 1-year survivors after first-ever stroke, 41% of all deaths within the subsequent 4 years are due to cardiovascular disease.5 Smoking is an established risk factor for first-ever stroke as well as for ischemic heart disease. Whether smoking is also a risk factor for recurrent stroke has been assessed in previous cohort studies, but the results have been contradictory.1,2 However, cohort studies have suggested that cessation of smoking after myocardial infarction is associated with a significant decrease in mortality.6 On the basis of the substantial evidence of smoking as a risk factor for first-ever stroke and ischemic heart disease, cessation of smoking is generally recommended after stroke to prevent myocardial infarction and recurrent stroke.7,8 Knowledge regarding modification of smoking habits after stroke is nevertheless scant.9,10 We therefore used data from a prospective study to assess modification of smoking habits and to identify predictors of persistent smoking after first-ever stroke.

Subjects and Methods
We performed a follow-up study of patients with first-ever stroke admitted to the only neurology department in the Danish county of Funen (population 465 000 inhabitants, 9% of the Danish population).

Definitions
Stroke was defined according to the World Health Organization criteria as “rapidly developing clinical signs of focal or global disturbance of cerebral function lasting more than 24 hours or leading to death with no apparent cause other than that of vascular origin.”5

A diagnosis of hemorrhagic stroke was considered if the clinical signs were compatible with stroke and an intracerebral hemorrhage was found at brain imaging. Cases with clinical signs of stroke were classified as ischemic stroke if CT or MRI scan excluded an intracerebral hemorrhage. Patients with clinical signs of stroke in whom brain imaging had not been performed were classified as clinical stroke cases. Cases with no previous stroke according to the medical record or to the structured interview were classified as...
first-ever stroke. Patients with subarachnoid hemorrhage were not included in the study.

**Case Ascertainment**

The local catchment area of the Department of Neurology at Odense University Hospital consists of Odense City and the surrounding municipalities. Patients with stroke and residency in this area are admitted to the Department of Neurology irrespective of age and stroke severity. Patients with stroke and residency in one of the remaining municipalities are admitted either to the Department of Neurology or to the medical departments of 4 general hospitals. In Denmark, hospitalization and access to medical care are free of charge.

We prospectively registered all patients admitted to the Department of Neurology because of a possible stroke from August 1, 1999, to January 31, 2001. Trained physicians at the Department of Neurology completed a case record form for each patient within 24 hours after admission. The case record form comprised information on stroke severity according to predefined criteria. A trained research nurse and a neurologist (S.B., S.H.S., T.A.) daily checked the records and case record forms of all patients admitted to the department. Cases with possible stroke were identified, and informed consent was obtained from the patient or relatives. After informed consent was obtained, patients were interviewed and examined by the research nurse or by a neurologist (S.B.). Information on hypertensive, diabetes, myocardial infarction, and previous stroke was collected. Smoking habits were recorded with regard to current and previous consumption, duration of smoking, and, for ex-smokers, time since quitting smoking. Daily consumption of cigarettes, cheroots, and cigars was calculated by equating 1 cigarette to 1 g, 1 cheroot to 3 g, and 1 cigar to 5 g of tobacco. Smoking was categorized as never smoker, former smoker, current light smoker (≤1 cigarette/day), current moderate smoker (1 to 14 cigarettes/day), and current heavy smoker (≥15 cigarettes/day). Smoking reduction was defined as a reduction of the daily tobacco consumption by ≥50% at follow-up, without quitting entirely. Advice on modification of stroke risk factors was part of the usual treatment. No particular efforts regarding advice on cessation of smoking were provided in relation to the present study.

Alcohol consumption per week was classified as no regular intake (<1 drink), moderate intake (men, 1 to 21 drinks; women, 1 to 14 drinks), and high intake (men, >21 drinks; women, >14 drinks). The lower limits of high alcohol intake were equivalent to the current guidelines used in a previous study. One drink (12 g of alcohol) was considered equivalent to a beer, a glass of wine, or a single measure of spirits. Body mass index was based on self-reported height and weight on admission and was calculated as weight in kilograms divided by the square of height in meters. Body mass index was categorized as low or normal (<25), overweight (25 to 29), and obese (≥30).

Education was stratified into 3 categories according to the total years of education: basic (≤8 years), secondary (9 to 10 years), and higher (≥11 years). Occupation during most of the patient’s life was divided into white-collar worker (nonmanual), entrepreneur and farmer, and blue-collar worker (manual). Housewives and patients with long-term unemployment or who had received early retirement pension were classified as “others.”

The presence of concomitant diseases was assessed by information obtained at the interview and supplemented by medical record information. Patients were specifically asked whether a physician had ever told them they suffered from a number of diseases, including hypertension, diabetes, myocardial infarction, and previous stroke.

After discharge, data from the medical records were abstracted in a structured form by a neurologist (S.B.). Information on hyperten-
sion, diabetes, atrial fibrillation, myocardial infarction, and previous stroke was recorded. Furthermore, information on blood tests, ECG, and brain imaging was abstracted from the records.

Follow-Up
Patients who participated in the interview during hospitalization and who were still alive 6 months after stroke admission were invited to a second structured interview. Patients who declined to attend the outpatient clinic for examination were offered a telephone interview. The second interview was identical to the first with regard to smoking, alcohol intake, and functional ability. The Barthel Index was used to assess persistent functional impairment. Patients were interviewed by the trained research nurse or by a neurologist (S.B.). Relatives who participated in the interview were allowed to answer the questions if the patient was unable to take part.

Statistical Analyses
We used unconditional logistic regression to calculate the crude and adjusted odds ratios and 95% CIs of persistent smoking at 6 months after stroke in patients who were current smokers on admission. We adjusted for the effect of age (20 to 54 years, 55 to 74 years, and ≥75 years), sex, Barthel Index at follow-up (0 to 49, 50 to 99, and 100), education, occupation, marital status, body mass index, tobacco consumption, and alcohol consumption on admission. These factors were selected because of the plausible association between each of the factors and the risk of persistent smoking. Data on education and occupation were entered in separate models because of the close relationship between the 2 variables.

The χ² test (95% CI) was used for comparing proportions.

Inclusion of patients with residency in municipalities outside the local catchment area of the Department of Neurology was a potential source of selection bias. We therefore repeated all analyses after restricting the sample to patients with residency in the local catchment area. Information bias due to cognitive disturbances among patients and due to interview by relatives could also affect our results. We addressed this problem by repeating the analyses with patients and due to interview by relatives could also affect our results. We addressed this problem by repeating the analyses with patients who were still alive 6 months after stroke admission were invited to a second structured interview. Patients who declined to attend the outpatient clinic for examination were offered a telephone interview. The second interview was identical to the first with regard to smoking, alcohol intake, and functional ability. The Barthel Index was used to assess persistent functional impairment. Patients were interviewed by the trained research nurse or by a neurologist (S.B.). Relatives who participated in the interview were allowed to answer the questions if the patient was unable to take part.

Results
We identified 734 patients admitted to the Department of Neurology with first-ever stroke in the period August 1, 1999, to January 31, 2001. One hundred three patients (14%) died within 6 months of their admission, which left 631 patients for the present study. A total of 511 patients (81%) participated in the interview both on admission and at follow-up. Nonparticipants were older and suffered more severe strokes than participants (Table 1).

On admission, 198 patients (38.7%) were current smokers. Of these, 165 (83.3%) were cigarette smokers. Forty-three patients (21.7%) who were current smokers on admission gave up smoking within 6 months of their stroke (Table 2). Furthermore, 16 (18.2%) of the moderate smokers and 21 (21.2%) of the heavy smokers had reduced their tobacco consumption by ≥50%. The median reduction of consumption was 5 g/d (range, 3 to 10 g/d) in moderate smokers and 15 g/d (range, 9 to 30 g/d) in heavy smokers, who reduced their consumption by ≥50%. Among 188 patients who were former smokers on admission, 22 (11.7%) resumed smoking within 6 months of their stroke (Table 2).

Male sex, having no disability at follow-up, living alone, and being a blue-collar worker were independently associated with an increased risk of persistent smoking after stroke (Table 3). A tendency for patients with high tobacco consumption before admission to have a higher risk of persistent smoking was not statistically significant. As expected, educational level and occupational status were closely related. Thus, 77% of patients with >11 years of education were white-collar workers. Entering educational level instead of occupation in separate models revealed a tendency for increased risk of persistent smoking in patients with <9 years of education, but the result was not statistically significant (data not shown).

The relative risk estimates of persistent smoking at follow-up did not change materially after restriction of the sample to 374 cases (73.2%) who were residents in the local catchment area of the Department of Neurology or after restriction to 237 cases (46.4%) who were able to participate without help from relatives and for whom the interview was easily performed (results not shown). Current smokers at follow-up were predominantly male, aged <75 years, and with no functional disability (Table 4). In addition to current smoking, 44% of these patients had at least 1 concomitant...
disease acting as a risk factor for stroke (hypertension, atrial fibrillation, or diabetes).

Discussion

We found that one fifth of smokers stopped smoking within 6 months of suffering from a stroke. Male sex, having no disability, living alone, and being a blue-collar worker were independently associated with an increased risk of persistent smoking after stroke. The major advantage of the present study was the application of data from a prospective follow-up study with detailed information on smoking status and several potential predictors for cessation of smoking.

Previously, only 2 studies have assessed modification of smoking habits after stroke. In a cohort of 717 patients with first-ever stroke, 35% of smokers gave up smoking within 3 months after stroke. An additional 26% of the smokers reduced their tobacco consumption. Cessation of smoking was positively associated with nonwhite ethnicity and living in residential care, a hospital, or a nursing home. Age, sex, and physical functioning were not associated with cessation of smoking. A trend for nonmanual workers being twice as likely to give up smoking compared with manual workers was not statistically significant. Other sociodemographic factors, including marital status and education, were not assessed in the study. In a retrospective study of 61 patients treated in a stroke clinic at a tertiary referral center, 35% were current smokers on admission. None of the patients quit smoking during the 2-year study period despite the physicians’ advice.

The rate of cessation of smoking in our study was lower than what has been reported in most previous studies on smoking after stroke and myocardial infarction. Variations in study design, patient characteristics, and time to follow-up may at least partly explain some of these differences.

Reduced smoking has been proposed as a method to decrease the risk of smoking-related diseases and to facilitate subsequent cessation of smoking in smokers who are not prepared to give up smoking. In our study one fifth of the smokers reported that they reduced their smoking by ≥50% within 6 months after their stroke. Previous studies have indicated that reduction of tobacco consumption by ≥50% might increase the rate of subsequent cessation of smoking. Whether this also applies to patients who reduce their smoking within the first months after a stroke is, however, unknown.

We found that 12% of patients who were former smokers on admission resumed smoking after stroke, although half of these patients reported a tobacco consumption of <1 g/d. This emphasizes that advice on smoking should also be considered in former smokers.

In our study male sex was associated with persistent smoking at 6 months after stroke. A tendency for a lower risk of persistent smoking in the elderly was not statistically significant. The results from other studies of patients with stroke or ischemic heart disease have been ambiguous with regard to the association between age, sex, and smoking cessation. Our results support the previously observed trend for patients with stroke and nonmanual occupation to have a lower risk of persistent smoking at follow-up. A positive association between educational level and cessation of smoking has been found in patients with myocardial infarction and in women from an unselected population of smokers, but these studies provided no information on occupation.

The importance of marital status on cessation of smoking after stroke has not been assessed in previous studies. We found that the risk of persistent smoking at 6 months after a stroke was significantly lower in patients with a partner compared with patients who were single. It is still unknown whether these results reflect a tendency to provide better information to patients who are married and have a nonmanual occupation or whether these patients are more liable to seek out information and to comply with advice on cessation of smoking after stroke. Additionally, the influence of a partner insisting that the patient must give up smoking might be important and should be considered in further studies.

Patients with severe disability after stroke were at lower risk of persistent smoking than nondisabled patients. The same tendency, although not statistically significant, was found in a previous study. It is conceivable that severely disabled patients are more motivated to quit smoking. Alternatively, the finding could reflect the inability of these patients to manipulate cigarettes and matches or lighters.

Smoking is a well-established risk factor for stroke in people aged <75 years but is a less obvious factor in the elderly. In our study, 80% of persistent smokers at 6

### TABLE 2. Smoking Habits on Admission and at 6-Month Follow-Up

<table>
<thead>
<tr>
<th>Smoking Habits on Admission</th>
<th>Nonsmoker</th>
<th>Light Smoker (≤1 g/d)</th>
<th>Moderate Smoker (1–14 g/d)</th>
<th>Heavy Smoker (≥15 g/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never smoker</td>
<td>122 (100.0)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Former smoker</td>
<td>166 (88.3)</td>
<td>10 (5.3)</td>
<td>9 (4.8)</td>
<td>3 (1.6)</td>
</tr>
<tr>
<td>Current light smoker (≤1 g/d)</td>
<td>4 (36.4)</td>
<td>4 (36.4)</td>
<td>2 (18.2)</td>
<td>1 (9.1)</td>
</tr>
<tr>
<td>Current moderate smoker (1–14 g/d)</td>
<td>22 (25.0)</td>
<td>1 (1.1)</td>
<td>56 (63.6)</td>
<td>9 (10.2)</td>
</tr>
<tr>
<td>Current heavy smoker (≥15 g/d)</td>
<td>17 (17.2)</td>
<td>7 (7.1)</td>
<td>29 (29.3)</td>
<td>46 (46.5)</td>
</tr>
</tbody>
</table>

Values are number (%).
months after stroke were aged <75 years and thus were within the age group with the highest stroke risk due to smoking.

There are a number of potential weaknesses in our study. The study population included only hospitalized stroke cases. However, a recent epidemiological study of stroke incidence in Denmark showed that only 6% of all nonfatal stroke cases are treated outside of hospitals. Patients who participated in the interview only during hospitalization were more frequently current smokers compared with patients who also completed the interview at follow-up, indicating that the prevalence of smoking is probably underestimated. Selection bias might also have been introduced because of inclusion of patients with residency outside the local catchment area of the neurology department. However, repeating the analyses while restricting the material to patients with residency in the local catchment area had no influence on the results. Information on current smoking was self-reported and not validated by any biochemical marker. Self-reported smoking habits, however, have been found to be accurate in studies of different populations.

<table>
<thead>
<tr>
<th>TABLE 3. Risk of Persistent Smoking at 6 Months After First-Ever Stroke in Patients Who Were Current Smokers on Admission</th>
<th>Stopped Smoking (n=43)</th>
<th>Persistent Smoking (n=155)</th>
<th>Crude Odds Ratio (95% CI)</th>
<th>Adjusted Odds Ratio* (95% CI)</th>
<th>P†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male</td>
<td>23</td>
<td>109</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>20</td>
<td>46</td>
<td>0.5 (0.2–1.0)</td>
<td>0.4 (0.1–1.0)</td>
</tr>
<tr>
<td>Age at follow-up, y</td>
<td>20–54</td>
<td>10</td>
<td>44</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>55–74</td>
<td>22</td>
<td>86</td>
<td>0.9 (0.4–2.0)</td>
<td>0.5 (0.2–1.4)</td>
</tr>
<tr>
<td></td>
<td>≥75</td>
<td>11</td>
<td>25</td>
<td>0.5 (0.2–1.4)</td>
<td>0.3 (0.1–1.2)</td>
</tr>
<tr>
<td>Barthel Index at follow-up</td>
<td>100</td>
<td>26</td>
<td>107</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>50–95</td>
<td>10</td>
<td>45</td>
<td>1.1 (0.5–2.5)</td>
<td>0.9 (0.3–2.6)</td>
</tr>
<tr>
<td></td>
<td>0–45</td>
<td>7</td>
<td>3</td>
<td>0.1 (0.03–0.4)</td>
<td>0.1 (0.02–0.5)</td>
</tr>
<tr>
<td>Marital status</td>
<td>Living alone</td>
<td>9</td>
<td>57</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Living with partner</td>
<td>30</td>
<td>92</td>
<td>0.5 (0.2–1.1)</td>
<td>0.2 (0.1–0.6)</td>
</tr>
<tr>
<td></td>
<td>Others‡</td>
<td>4</td>
<td>6</td>
<td>0.2 (0.1–1.0)</td>
<td>0.1 (0.02–0.6)</td>
</tr>
<tr>
<td>Occupation</td>
<td>Blue collar</td>
<td>16</td>
<td>80</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>White collar</td>
<td>16</td>
<td>40</td>
<td>0.5 (0.2–1.1)</td>
<td>0.3 (0.1–0.8)</td>
</tr>
<tr>
<td></td>
<td>Entrepreneurs</td>
<td>6</td>
<td>22</td>
<td>0.7 (0.3–2.1)</td>
<td>1.0 (0.3–3.5)</td>
</tr>
<tr>
<td></td>
<td>Others§</td>
<td>5</td>
<td>13</td>
<td>0.5 (0.2–1.7)</td>
<td>1.5 (0.3–6.9)</td>
</tr>
<tr>
<td>Tobacco consumption</td>
<td>Light or moderate smoker</td>
<td>26</td>
<td>73</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Heavy smoker</td>
<td>17</td>
<td>82</td>
<td>1.7 (0.9–3.4)</td>
<td>1.6 (0.7–3.7)</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td>No regular intake</td>
<td>20</td>
<td>37</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Moderate intake</td>
<td>18</td>
<td>89</td>
<td>2.7 (1.3–5.6)</td>
<td>2.1 (0.8–5.2)</td>
</tr>
<tr>
<td></td>
<td>High intake</td>
<td>4</td>
<td>29</td>
<td>3.9 (1.2–12.7)</td>
<td>2.7 (0.7–11.1)</td>
</tr>
<tr>
<td>Body mass index</td>
<td>Low or normal</td>
<td>18</td>
<td>78</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Overweight</td>
<td>18</td>
<td>55</td>
<td>0.7 (0.3–1.5)</td>
<td>0.7 (0.3–1.8)</td>
</tr>
<tr>
<td></td>
<td>Obese</td>
<td>7</td>
<td>21</td>
<td>0.7 (0.3–1.9)</td>
<td>0.5 (0.1–1.7)</td>
</tr>
</tbody>
</table>

*Adjusted for sex, age, Barthel Index at 6 months after stroke, marital status, occupation, and tobacco consumption before stroke.
†For adjusted odds ratios.
‡Living with family or friends or institutionalized.
§Housewife, long-term unemployment, and other unclassifiable occupations.
||Tobacco consumption before stroke.
with ischemic heart disease, misclassification of current smoking occurred in only 7% of the cases, and misclassification was not related to age, sex, or employment status. It is possible, however, that the amount of tobacco consumed was underreported, indicating that some heavy smokers might have been misclassified as moderate smokers. This would imply an even greater need for interventions to reduce and stop smoking after stroke. Finally, information bias due to cognitive disturbances among the patients and due to proxy interviews might have affected our results. Repeating the analyses with the inclusion of relatives and for whom the interview was easily performed did not materially change the results.

Whether cessation of smoking after stroke reduces the risk of new, major vascular events is unknown, and further studies are needed to assess the potential benefits of cessation of smoking after stroke. However, despite current lack of proof, advice on cessation of smoking is included in the strategy for secondary prevention in patients with stroke. Our results suggest that more efficient antismoking counseling is required to reduce the proportion of persistent smokers after stroke. This counseling should take into account the increased risk of persistent smoking in men, patients with no disability, blue-collar workers, and patients living alone.

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References


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