Cerebral arterial aneurysm formation and rupture in 20,767 elderly patients: hypertension and other risk factors

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Cerebral arterial aneurysms are common in the general population and their rupture is a catastrophic event. Considerable uncertainty remains concerning the conditions that predispose individuals to aneurysm formation or rupture. The role of systemic hypertension in aneurysm formation and rupture has been especially controversial. Demographic variables have rarely been addressed because of the small sample sizes in previous studies. The authors describe the demographics and prevalence of hypertension in 20,767 Medicare patients with an unruptured aneurysm and compare these to a random sample of the hospitalized Medicare population. The prevalence of hypertension in patients with unruptured aneurysms was 43.2% compared with 34.4% in the random sample.

Patients who survived their initial hospitalization were separated into two groups: those with an unruptured cerebral aneurysm as the primary diagnosis and those with an unruptured cerebral aneurysm as a secondary diagnosis. Follow-up data for 18,119 patients were examined to determine the risk of subarachnoid hemorrhage (SAH) associated with age, gender, race, hypertension, insulin-dependent diabetes mellitus, and surgical treatment. For patients with an unruptured cerebral aneurysm as the primary diagnosis, hypertension was found to be a significant risk factor for future SAH (risk ratio: 1.46, 95% confidence interval (CI): 1.01–2.11), whereas surgical treatment (risk ratio: 0.29, 95% CI: 0.09–0.97) had a significant protective effect. Advancing age had a small but significant protective effect in both groups.

Elderly patients identified with unruptured aneurysms are more likely to have coexisting hypertension than the general hospitalized population. In elderly patients hospitalized with an unruptured cerebral aneurysm as their primary diagnosis, hypertension is a risk factor for subsequent SAH, whereas surgical treatment is a protective factor against SAH.

KEY WORDS • cerebral aneurysm • hypertension • risk factor • subarachnoid hemorrhage • stroke

Data Source

The Health Care Financing Administration (HCFA) maintains a computerized database that includes information coded from a standardized billing form (HCFA form
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1450, UB-82) submitted to HCFA for every hospital admission of a Medicare patient. In the United States, 96% of persons 65 years old or older are enrolled in Medicare. Each record in the database represents a separate admission and includes an encrypted form of the patient’s social security number, age, gender, race, one primary diagnosis, and up to four secondary diagnoses (four comorbid conditions). The diagnoses and up to three surgical procedures are coded according to the International Classification of Disease, Ninth Revision (ICD-9). Also included in the record are the admission date, discharge date, and the date the patient died if death occurred within 2.5 years of the admission date.

**Patient Selection**

The study population was selected from the HCFA data for all hospitalized patients discharged between January 1, 1984 and December 31, 1991. We first selected all patients with a discharge diagnosis of “cerebral aneurysm, unruptured” (ICD-9: 437.30–437.39) made at any time during the 8-year study period. Each patient was counted only once, regardless of the number of times they had been diagnosed with an unruptured aneurysm. Patients less than 65 years of age or those living outside the United States are not part of the database and therefore are not included in this study. The prevalence rate of the diagnosis of unruptured cerebral aneurysm was calculated from the records of these patients as compared to the 1985 population data reported by the United States Bureau of the Census. Because cerebral aneurysms that are symptomatically more commonly prompt investigation, the number of patients in this study identified with an unruptured cerebral aneurysm represents the actual prevalence rate of the diagnosis, but not the total prevalence of cerebral aneurysms in the population.

**Analysis of Hypertension and Demographic Data**

Hypertension was defined by ICD-9 codes 401.00 through 405.99 or 437.20 through 437.29, appearing as a discharge diagnosis at any time during the 8 years studied (8-year prevalence). To characterize patients with unruptured aneurysms, we compared the demographics and prevalence of hypertension in our patients to those of a random sample of three per 1000 hospitalized Medicare patients from each year. After eliminating 249 patients who had a diagnosis of unruptured cerebral aneurysm or SAH (ICD-9 430.00–430.99) at some time during the 8 years of available data, 233,851 patients remained. These were compared to the patients diagnosed with unruptured cerebral aneurysms using the simple chi-square test without adjusting for any other variables. Because the random sample of hospitalized patients included a wide variety of morbid conditions that may be related to hypertension and vascular disease, this was not a true control group and no causal relationship for aneurysm formation is implied from this comparison.

**Analysis of Risk Factors for SAH**

To study the risk factors for SAH in patients diagnosed with unruptured cerebral aneurysms, we excluded patients who had a concurrent diagnosis of SAH or a record of in-hospital death at the time of their initial diagnosis of unruptured cerebral aneurysm from further analysis. The remaining patients were separated into two groups: those with unruptured cerebral aneurysm occurring as the primary diagnosis and those with unruptured cerebral aneurysm occurring as a secondary diagnosis. Patients with unruptured cerebral aneurysm as the primary diagnosis were more likely to have presented with symptoms related to their aneurysm, whereas patients with unruptured cerebral aneurysm as a secondary diagnosis were likely to have had their aneurysm discovered incidentally during workup for some other central nervous system disease or neurological symptoms unrelated to the aneurysm. The characteristics of the two groups were compared using the simple chi-square test without adjusting for any other variables. The records of both groups of patients were examined for SAH occurring within 2.5 years of the initial diagnosis of unruptured aneurysm. Because the cause of death in patients who died outside the hospital was not known, the incidence of SAH is underestimated in both groups. Univariate and multivariate logistic regression and Cox’s proportional hazards model were used to determine in both groups the association between age, gender, race, hypertension, insulin-dependent diabetes mellitus, surgical treatment (ICD-9 codes: 383.1, 383.2, 384.1, 384.2, 385.1, 385.2, 386.2, 388.1, or 388.2), the number of comorbidities at initial diagnosis of unruptured cerebral aneurysm, and the risk of SAH. To eliminate any potential bias due to out-of-hospital deaths, all statistical analyses were repeated after excluding patients who died during the follow-up period. All statistical analyses were performed using commercially available software (SAS/Graph, Version 6, SAS Institute, Cary, NC).

**Results**

In the 8 years studied, 20,767 Medicare patients were admitted to a hospital and were diagnosed with an unruptured cerebral aneurysm (Table 1). The average age of these patients was 73.8 ± 6.7 years (± standard deviation); 70% were women and 6.8% were African American. The 8-year incidence of SAH in all patients was 7.6% (76.5 ± 7.6). The number of cases was 20,767 with a discharge diagnosis of cerebral aneurysm. Patients with unruptured cerebral aneurysm represented the actual prevalence rate of the patients in this study identified with an unruptured cerebral aneurysm occurring as the primary diagnosis.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Unruptured Cerebral Aneurysm Cases</th>
<th>Random Sample</th>
<th>Odds Ratio</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>no. of cases</td>
<td>20,767</td>
<td>233,851</td>
<td>—</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>mean age (yrs)*</td>
<td>73.8 ± 6.7</td>
<td>76.5 ± 7.6</td>
<td>—</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>female (%)</td>
<td>70.0</td>
<td>57.3</td>
<td>1.72</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>African American (%)</td>
<td>6.8</td>
<td>7.7</td>
<td>0.87</td>
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</tr>
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<td>hypertension (%)§</td>
<td>43.2</td>
<td>34.4</td>
<td>1.45</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

* Mean age expressed as standard deviation. — = not applicable.
† The p value is based on the t-test with unequal variance.
‡ The p value is based on the chi-square test without adjusting for covariates.
§ Percentage denotes the 8-year prevalence rate.
SAH, who were alive at the time of discharge. We assumed these patients to have one or more unruptured aneurysms diagnosed secondary to symptoms, exclusive of rupture, or discovered incidentally during workup for unrelated disease. The average age was 73.9 ± 6.7 years. Seventy-five percent of the patients in our study group were aged between 65 and 78 years; 95% were between 65 and 87 years, and the oldest patient was 101 years. The follow-up study population was 31% male and 6.5% African American. For this study, 795 patients with race identified as “other” or “unknown” (4.4% of the study group) were included in the “Caucasian” cohort.

The most common primary and secondary diagnoses in all 18,119 patients are shown in Table 2. The diagnosis of hypertension was coded at the time of first discharge with diagnosis of unruptured cerebral aneurysm for 5379 patients (29.7%). At the time of first discharge with the diagnosis of unruptured cerebral aneurysm, 1197 patients (6.6%) had no comorbidities (secondary diagnoses) recorded, 2154 patients (11.9%) had one comorbidity, 3219 (17.8%) had three comorbidities, and 8770 (48.4%) had four comorbidities. Unruptured cerebral aneurysm was the primary diagnosis for 7113 patients (39.3%) and, for 11,006 patients (60.7%), it was a secondary diagnosis. Comparison of the characteristics of patients with unruptured cerebral aneurysm as the primary diagnosis versus those with unruptured cerebral aneurysm as a secondary diagnosis is shown in Table 3.

Of the follow-up study population, 13.5% of women and 10.5% of men (p < 0.001) were treated surgically. The oldest patient treated surgically was 89 years old. The difference in the percentage of patients receiving surgical treatment based on race was not significant (Caucasian 12.6%, African American 11.7%; p = 0.34). Patients who underwent surgical treatment were, on average, younger, less likely to have coexisting hypertension, less likely to have coexisting insulin-dependent diabetes mellitus, and had fewer comorbidities than the total follow-up study population. In this study, 1938 patients (27.2%) with unruptured cerebral aneurysm as the primary diagnosis and 340 patients (3.1%) with unruptured cerebral aneurysm as a secondary diagnosis received surgical (or, less likely,
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endovascular) treatment for at least one unruptured aneurysm. It is impossible to determine from our data how many patients were known to have more than one unruptured aneurysm or how many aneurysms were left untreated in any given patient.

The diagnosis of SAH was made within 2.5 years in 119 patients (1.7%) with unruptured cerebral aneurysm as the primary diagnosis and 98 patients (0.9%) with unruptured cerebral aneurysm as a secondary diagnosis. The rates of at-risk patients with unruptured cerebral aneurysm as the primary diagnosis who had SAH within 1, 2, and 2.5 years were 1.5%, 1.7%, and 2.0%, respectively, and the rates of patients with unruptured cerebral aneurysm as a secondary diagnosis with SAH in the same time periods were 0.9%, 1.0%, and 1.3%, respectively. There were 5155 patients recorded as dead during the follow-up period without diagnosis of SAH (28.5% of the 18,119 in the study group). The remaining 12,747 patients (70.3%) were alive without SAH 2.5 years after their last hospital admission.

The diagnosis of hypertension was a significant risk factor for the future development of SAH (risk ratio: 1.46, 95% confidence interval (CI): 1.01–2.11) in patients with unruptured cerebral aneurysm as the primary diagnosis. Age (risk ratio: 0.96, 95% CI: 0.92–0.99) and surgical treatment (risk ratio: 0.29, 95% CI: 0.09–0.97) were found to be significant protective factors in this group (Table 4). The only significant variable for patients with unruptured cerebral aneurysm as a secondary diagnosis was age (risk ratio: 0.96, 95% CI: 0.92–0.99); neither hypertension nor surgical treatment were significant variables in this group. Gender, race, insulin-dependent diabetes mellitus, and the number of comorbidities at initial diagnosis of unruptured cerebral aneurysm were not found to significantly predict risk of future SAH in either group.

Exclusion of the 5155 patients who were known to have died within 2.5 years of diagnosis of unruptured cerebral aneurysm without diagnosis of SAH did not produce significant alteration of these results.

Discussion

We have reported data from 20,767 Medicare patients diagnosed with an unruptured cerebral aneurysm. We have shown that in this population the diagnosis of unruptured cerebral aneurysm is made more commonly in women than in men and in Caucasians than in African Americans, but that gender and race do not predict future aneurysm rupture. Hypertension was diagnosed more frequently in patients with unruptured aneurysms than in the general hospitalized Medicare population and was a significant risk factor for SAH in patients with unruptured cerebral aneurysm as their primary diagnosis. Although our patients were elderly and had a relatively low risk of aneurysm rupture, surgical treatment was a statistically significant protective factor against future SAH in patients with unruptured cerebral aneurysm as their primary diagnosis.

The HCFA database has been used frequently in recent years for a wide variety of research purposes involving the etiology, outcome, and epidemiology of various diseases. The characteristics of these data have been described in detail elsewhere. There are a number of biases that may impact the results of this study. Hypertension may be under- or over-reported in patients diagnosed with either an unruptured cerebral aneurysm or SAH. Because we have excluded patients with a record of SAH or in-hospital death at the time of aneurysm diagnosis from the follow-up study, we may have removed a significant number of hypertensive patients in whom an unruptured aneurysm was identified and SAH occurred during the same admission. In addition, because we did not know the cause of death for patients who died outside a hospital, we may have excluded a significant number of patients who died of SAH with or without underlying hypertension.

Natural History of Unruptured Cerebral Aneurysms

Numerous studies have attempted to determine the number of patients at risk for SAH based on the finding of unruptured aneurysms at autopsy or radiologically in patients not clinically suspected of harboring an aneurysm. The reported prevalence of unruptured aneurysms in autopsy series has ranged from 0.8% to 8.1%. Stehbens noted an increasing incidence with age, most occurring between 40 and 70 years. Inagawa and Hirano reported 10,259 autopsies with a peak incidence of unruptured aneurysms in those aged 60 to 69 years old. In contrast, McCormick reported a series of 3425 autopsies and found a “relatively uniform prevalence at all ages past twenty.” Radiological studies have reported finding unruptured aneurysms in 0.2% to 6.5% of the study population. A comparison between even the lowest estimate of the prevalence of unruptured aneurysms from these studies and our data would suggest that a large percentage of unruptured aneurysms remain undiagnosed in elderly patients.

The annual risk of rupture of intact aneurysms is difficult to assess accurately due to the lack of an inexpensive, uniformly applied, noninvasive diagnostic method for detecting unruptured aneurysms, and the relatively low annual rate of aneurysm rupture. Various authors have reported follow-up data from patients who had unsuspected aneurysms diagnosed incidentally, patients who became symptomatic from an unruptured

<table>
<thead>
<tr>
<th>TABLE 4</th>
<th>Risk of developing SAH in 7,113 patients with unruptured cerebral aneurysm as the primary diagnosis*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor</td>
<td>Logistic Regression Analysis</td>
</tr>
<tr>
<td></td>
<td>Univariate</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.44</td>
</tr>
<tr>
<td>Age</td>
<td>0.96</td>
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<tr>
<td>Surgical treatment</td>
<td>0.57</td>
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</table>

* Comparison of the results from two different models. The stepwise approach was used for both models. Risk ratio (and 95% confidence interval) are given. SAH = subarachnoid hemorrhage.
Of the 12 patients over the age of 70 years experienced rupture of a previously intact aneurysm. In the cohort reported by Juvela, et al.,24 the median age of patients experiencing SAH was 36.8 years, whereas those who did not have an SAH had a median age of 42.7 years (p = 0.053). McCormick28 reported an autopsy series in which the rate of rupture was 81% of the aneurysms in patients aged 30 to 39 years, 60% in those aged 40 to 49 years, 42% in those aged 50 to 59 years, 25% in those aged 60 to 69 years, and 21% in those aged 70 to 79 years. Of 15 aneurysms in patients older than 79 years, none was proven to have ruptured.

Cerebral aneurysms have been observed more frequently in women than in men.5,9,17,28,30,40,46 Although our data show that unruptured aneurysms are diagnosed more commonly in elderly women than in elderly men, the gender of the patient was not a significant predictor of aneurysm rupture in this study.

McCormick and Nofzinger,30 who reviewed autopsy findings, and Ohaegbulam, et al.,36 who reviewed 244 cases of cerebral aneurysms diagnosed ante mortem, reported that the prevalence of cerebral aneurysms is higher in Caucasian than in African American patients. Our study revealed a higher prevalence of the diagnosis of unruptured cerebral aneurysm in Caucasian than in African American patients, but race was not a significant risk factor for aneurysm rupture.

**Hypertension.** Previous studies of hypertension and its role in aneurysm formation and rupture have been of three types: community studies, which compare the prevalence of hypertension with subsequent SAH, postmortem studies of patients identified with aneurysms, and ante mortem studies of patients known to harbor unruptured aneurysms.

a) Community studies. Reports from two separate community studies have disagreed on the role of hypertension as a risk factor for SAH. Phillips, et al.,41 reviewed the records of all residents of Rochester, Minnesota, who

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>No. of Cases</th>
<th>No. of Unruptured Aneurysms</th>
<th>Age (yrs) Mean</th>
<th>Age (yrs) Range</th>
<th>Sex M/F</th>
<th>No. of SAHs</th>
<th>Follow-Up Period (mos)</th>
<th>Annual Rupture Rate (%)</th>
<th>Risk Factors for SAH†</th>
<th>Significant</th>
<th>Not Significant</th>
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<td>Asari &amp; Ohmoto, 1993</td>
<td>54</td>
<td>72</td>
<td>60.5</td>
<td>34–74</td>
<td>20:34</td>
<td>11</td>
<td>43.7</td>
<td>1.92</td>
<td>4,6,7</td>
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<td>Juvela, et al., 1993</td>
<td>142</td>
<td>181</td>
<td>41.9</td>
<td>15–61</td>
<td>66:76</td>
<td>27</td>
<td>164.4</td>
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<td>48</td>
<td>53</td>
<td>ND</td>
<td>ND</td>
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<td>130</td>
<td>161</td>
<td>56.2</td>
<td>17–79</td>
<td>52:78</td>
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<td>47</td>
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<td>68</td>
<td>41</td>
<td>ND</td>
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<td>54</td>
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<td>38.5</td>
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<td>1–48</td>
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<td>47</td>
<td>7</td>
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</table>

* SAH = subarachnoid hemorrhage; ND = no data given.
† Risk factor codes: 1 = age; 2 = gender; 3 = blood pressure; 4 = hypertension; 5 = aneurysm diameter; 6 = aneurysm shape; 7 = aneurysm location; 8 = aneurysm direction; 9 = number of unruptured aneurysms; 10 = symptomatic vs. asymptomatic.

RISK FACTORS FOR ANEURYSM FORMATION AND RUPTURE

**Age, Gender, and Race.** In a comprehensive review of the literature concerning cerebral aneurysms, Weir20 noted that the rate of aneurysm rupture progressively increases with age, but that possibly there exists a decline in “extreme old age.” The finding in this study that increasing age is a significant protective factor against aneurysm rupture in patients over the age of 65 years is consistent with the observed age distribution of patients with SAH in a number of previous studies. In the series of Asari and Ohmoto,1 four of 22 patients less than 59 years old, seven of 20 patients between 60 and 69 years of age, and none of the 12 patients over the age of 70 years experienced rupture of a previously intact aneurysm. In the cohort reported by Juvela, et al.,24 the median age of patients experiencing SAH was 36.8 years, whereas those who did not have an SAH had a median age of 42.7 years (p = 0.053). McCormick28 reported an autopsy series in which the rate of rupture was 81% of the aneurysms in patients aged 30 to 39 years, 60% in those aged 40 to 49 years, 42% in those aged 50 to 59 years, 25% in those aged 60 to 69 years, and 21% in those aged 70 to 79 years. Of 15 aneurysms in patients older than 79 years, none was proven to have ruptured.

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<th>Sex M/F</th>
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<th>Annual Rupture Rate (%)</th>
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Cerebral aneurysm risk factors in the elderly

experienced SAH within a 30-year period. Of 98 patients with blood pressure recorded prior to their first SAH, systolic pressure was greater than 160 mm Hg in 28% and diastolic pressure was greater than 95 mm Hg in 30%. The prevalence of hypertension in these patients was considered “similar to figures for the prevalence of hypertension in a normal population of similar age.” Sacco, et al. reported data from 5184 residents of Framingham, Massachusetts, who were followed prospectively for 26 years; follow-up monitoring involved biennial examinations that included blood pressure measurement. The mean systolic and diastolic blood pressures of 36 patients experiencing SAH, calculated as an average of all measurements prior to the stroke and compared to four age- and gender-matched controls per case, were significantly higher for the patients having SAH than for those without.

b) Postmortem studies. The influence of systemic hypertension on the formation and rupture of cerebral aneurysms has been debated in the literature of autopsy studies without clear consensus. Kwak, et al. reported 811 patients with cerebral aneurysms diagnosed at autopsy; of these, 794 suffered aneurysm rupture prior to death. Hospital charts were reviewed for the diagnosis of hypertension, defined as systolic blood pressure greater than 150 mm Hg or diastolic blood pressure greater than 90 mm Hg. The authors compared the prevalence of hypertension in these patients with that in the Japanese population based on National Nutrition Surveys as reported by Sasaki. Hypertension was significantly more common in patients with ruptured or unruptured intracranial aneurysms than in the general population.

Cohen reported 585 postmortem examinations in which he found nine unruptured aneurysms. Based on hospital records of blood pressure and autopsy determinations of heart weight, he suggested that hypertension is a possible factor in aneurysm rupture but not related to aneurysm formation. In a report of 54 postmortem examinations including determination of heart weight, Sugai and Shoji stated that hypertension is related to both aneurysm formation and aneurysm rupture. McCormick and Schmalstieg compared 200 autopsies (cases with 100 ruptured and 100 unruptured aneurysms) to 500 autopsies from the “general” hospital population and 100 autopsies without intracranial aneurysms from the “neurological services.” Hypertension, as determined by clinical records and autopsy findings, was present in 30.0% of autopsies from the neurological services, 37.0% of those with ruptured aneurysms, 43.0% of those with unruptured aneurysms, and 43.6% from the general autopsy population. The authors did not consider hypertension to be a major factor in either aneurysm formation or rupture. Andrews and Spiegel compared the presence of hypertension recorded in patient charts of 212 autopsy subjects with aneurysms to data from the Department of Health, Education, and Welfare national health survey. The authors compared systolic and diastolic blood pressures across age groups and concluded that there was no evidence to suggest that hypertension was necessary for the development of most clinically diagnosed aneurysms, but that elevated blood pressure may accelerate the effects of atherosclerosis in producing multiple aneurysms of detectable size. Contingency table analysis of 737 aneurysm patients, performed by Østergaard and Høg, also suggested a role for hypertension in the formation of multiple intracranial aneurysms.

More recently, de la Monte et al. reported a case-control autopsy study that included 39 subjects with unruptured aneurysms and 131 subjects with ruptured cerebral aneurysms. Systemic arterial hypertension recorded in the patients’ clinical records was related to an increased risk of aneurysm formation (odds ratio: 2.25, p < 0.001). The authors also found a high degree of correlation between severe acute hypertension, defined as diastolic blood pressures greater than 110 mm Hg at the time of last admission to the hospital, and aneurysm rupture (odds ratio: 30.2, p < 0.001). The percentage of patients whose last admission was due to the ruptured aneurysm and the method of defining “acute” hypertension were not reported.

c) Ante mortem studies. A number of authors who have reported series of patients with unruptured aneurysms diagnosed ante mortem have commented on risk factors for future rupture. Wiebers et al. identified 65 patients ranging from 17 to 79 years old with 81 unruptured aneurysms followed for at least 5 years after diagnosis. Multivariate analysis was used to determine the relationship between a variety of risk factors (shown in Table 5) and aneurysm rupture. Systolic and diastolic blood pressures at the time of aneurysm diagnosis were not found to be significant predictors of subsequent rupture. An additional 65 patients with 80 intact aneurysms were later added to the cohort with no change in the significance of risk factors. Juvela et al. reported 142 patients with 181 unruptured aneurysms followed for at least 10 years. Cox’s proportional hazards model was used to determine the significance of nine variables (shown in Table 5) and the risk of aneurysm rupture. The presence of hypertension at the beginning of the follow-up period and blood pressure measurements (systolic, diastolic, and mean, analyzed separately and with age and aneurysm size as fixed covariates) were not found to be significant predictors of future SAH.

Winn et al. described 38 patients with a mean age of 47 years who developed SAH and were found to have multiple aneurysms; only the ruptured aneurysms were treated surgically. Two patients rebled from surgically treated aneurysms, three suffered rupture of previously intact aneurysms, and five patients developed SAH without a definite source of bleeding being identified. The only variable found to be significant when comparing hospital admission data from these 10 patients to those of patients who did not bleed was systolic blood pressure (p < 0.03). Cox’s proportional hazards model was used by Asari and Ohmoto to analyze data from 54 patients with 72 unruptured aneurysms in whom the follow-up period averaged 43.7 months. The mean age of these patients was 60.5 years (range 34–74 years). Hypertension, identified by reviewing medical records, was found significant in predicting future aneurysm rupture (p = 0.034).

d) Health Care Financing Administration data. Our results show that patients diagnosed with an unruptured cerebral aneurysm are more likely also to have a diagnosis of hypertension than hospitalized patients without unruptured aneurysms. Although this information is useful for descriptive purposes, it must be remembered that ours is not a case-control study and conclusions about causation...
should not be drawn from differences between these two populations. In patients with unruptured cerebral aneurysm as their primary diagnosis, a diagnosis of hypertension at any time during the follow-up period was found to be a significant risk factor for SAH within 2.5 years. From this we conclude that systemic hypertension is an independent risk factor for aneurysm rupture in patients presenting with symptoms attributed to an intact aneurysm.

Surgical Treatment. Patients with unruptured cerebral aneurysm as the primary diagnosis were treated surgically much more frequently than patients with unruptured cerebral aneurysm as a secondary diagnosis. The annual risk of SAH was significantly higher in the patients with unruptured cerebral aneurysm as their primary diagnosis were treated surgically presenting with symptoms attributed to an intact aneurysm. Medicare patients with unruptured cerebral aneurysm as their primary diagnosis. Both surgical treatment for unruptured cerebral aneurysms and increasing patient age decrease the risk of future SAH in Medicare patients with unruptured cerebral aneurysms as their primary diagnosis.

Conclusions

The demographics and prevalence of hypertension in hospitalized Medicare patients have been described. Patients’ gender and race are not significant predictors of aneurysm rupture. We have shown that hypertension is an independent risk factor for SAH due to rupture of a previously intact aneurysm in Medicare patients with unruptured cerebral aneurysm as their primary diagnosis. Both surgical treatment for unruptured cerebral aneurysms and increasing patient age decrease the risk of future SAH in Medicare patients with unruptured cerebral aneurysms as their primary diagnosis.

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