Increasing Trends in Hospitalization for Atrial Fibrillation in the United States, 1985 Through 1999
Implications for Primary Prevention

Wendy A. Wattigney, MStat; George A. Mensah, MD, FESC; Janet B. Croft, PhD

Background—Atrial fibrillation, the most common sustained disturbance of heart rhythm, is associated with a 5-fold increase in the incidence of ischemic stroke.

Methods and Results—The National Hospital Discharge Survey was used to estimate the annual number and prevalence of hospitalizations with atrial fibrillation among men and women 35 years of age or older. From 1985 through 1999, hospitalizations increased from 154,086 to 376,487 for a first-listed diagnosis and from 787,750 to 2,283,673 for any diagnosis. Prevalence was higher among successive age groups. Age-standardized prevalence was consistently higher among men than women. In 1999, essential hypertension, ischemic heart disease, congestive heart failure, and diabetes were prominent coexisting conditions. The number of male patients discharged home decreased from 77% to 63%, whereas the number of discharges to long-term care increased from 9% to 15%; the corresponding values for women were 72% to 56% and 15% to 23%. A slight increase in discharges to short-term care was indicated, whereas no trends were noted for in-hospital mortality.

Conclusions—Hospitalizations for atrial fibrillation have increased dramatically (2- to 3-fold) in recent years. The public health burden of atrial fibrillation is enormous and expected to continue to increase over the next decades. Primary prevention of atrial fibrillation must be recognized and pursued as a complementary management strategy for reducing cardiovascular morbidity and mortality. (Circulation. 2003;108:711-716.)

Key Words: arrhythmia ■ atrial flutter ■ cardiovascular diseases ■ morbidity

Atrial fibrillation is the most common sustained heart rhythm disturbance, affecting an estimated 2.3 million adults in the United States.1-2 Until studies began to link stroke with atrial fibrillation in the late 1960s, atrial fibrillation was thought to have a minor impact on morbidity and mortality.3 Evidence has emerged from autopsy and clinical and epidemiologic data that strongly links atrial fibrillation to stroke.4 This and other studies have shown that atrial fibrillation is an independent risk factor for stroke, a powerful contributor to increased mortality and medical cost.3,5-7

The prevalence of atrial fibrillation increases markedly with age in older adults, from <1% in adults younger than 55 years to roughly 1 in every 10 persons 80 years of age or older.1,2 Men are more likely than women to have atrial fibrillation regardless of age, and among older adults the prevalence is higher in white than in black populations.2,8 In addition to these nonmodifiable risk factors, other independent risk factors predisposing to the development of atrial fibrillation include hypertension, congestive heart failure, diabetes, and previous myocardial infarction.9 Mortality with atrial fibrillation has increased dramatically over the last 2 decades, with the age-standardized death rate (per 100,000 in United States population) increasing from 27.6 in 1980 to 69.8 in 1998.10 Projections are that by the year 2025, 3.3 million adults in the United States will have atrial fibrillation, with >35% of affected persons 80 years of age or older.2

Trends in the hospitalization of Medicare beneficiaries 65 years of age and older with cardiac conduction disorders or arrhythmias from 1991 through 1998 show atrial fibrillation consistently as the most frequent of these disorders.11 Furthermore, the greatest increase in discharges over the 8-year interval among these disorders was seen for atrial fibrillation. Discharge rates for atrial fibrillation also increased with increasing age, were higher among white than black patients, and were highest among white women 75 years of age and older. European studies of atrial fibrillation likewise show a dramatic increase in the number of hospitalizations for atrial fibrillation with an increase in incidence with increasing age.12,13 A study on the seasonal variation of atrial fibrillation found a winter peak and summer trough in the incidence of atrial fibrillation.14

The number of atrial fibrillation cases is expected to reach >5.6 million during the next 50 years as a result of the growing
number of elderly in the United States population, and the costs for caring for patients with atrial fibrillation after hospitalization will likely increase as well. Accordingly, we used the National Hospital Discharge Survey data to examine trends in United States hospitalizations for atrial fibrillation and discharge status after hospitalization among men and women with atrial fibrillation from 1985 through 1999. We also examined recent characteristics of persons hospitalized with atrial fibrillation and coexisting conditions.

Methods

Data Source
The National Hospital Discharge Survey (NHDS), conducted by the National Center for Health Statistics (NCHS) since 1965, includes demographic and medical information abstracted from medical records of inpatients selected from a nationally representative sample of nonfederal, short-stay hospitals in the United States. The NHDS provides information on patient characteristics, length of stay, diagnoses, and surgical and nonsurgical procedures. The International Classification of Diseases, 9th Rev, Clinical Modification (ICD-9-CM) was used for coding medical diagnoses and procedures. The agency uses stratified, multistage probability sampling designs to produce calendar year estimates. The sampling frame consisted of noninstitutional hospitals, exclusive of federal, military, and Veterans Administration hospitals, located in the 50 states and the District of Columbia. Since 1988, only hospitals with an average length of stay for all patients of <30 days or those whose specialty is general (medical or surgical) or children’s general were included in the survey. An additional inclusion criteria is that a hospital must have 6 or more staffed beds. Before 1988, hospitals with an average length of stay of 30 days or more were not included, regardless of specialty. Because persons with discharges during the year may be sampled more than once, estimates are for discharges, not persons. Detailed information on the NHDS has been published, and yearly survey publications can be obtained from the NCHS website at [http://www.cdc.gov/nchs/](http://www.cdc.gov/nchs/).

We analyzed the 1979 to 1999 National Hospital Discharge multiyear public use data file containing non-newborn records for survey years 1985 through 1999. Records were limited to patients 35 years of age or older with atrial fibrillation recorded as 1 of up to 7 diagnoses. In this report, atrial fibrillation is defined for patients with ICD-9-CM diagnosis codes 427.31 or 427.32, codes that include both atrial fibrillation and atrial flutter. Persons <35 years of age accounted for 1% of all patients diagnosed with atrial fibrillation. Racial groups were not considered in the analysis because of incomplete reporting on the record abstract. Underreporting of race on records for patients with any diagnosis of atrial fibrillation increased from 7% in the 1985 survey to 27% in 1999.

Statistics
Census bureau estimates of the United States civilian resident population, as of July 1, for the years 1985 through 1999 were used to calculate age- and sex-specific prevalence of hospitalization for atrial fibrillation per 10,000 members of the United States population. Because of the complex sample design of NHDS, these nationally representative estimates were calculated using weighted analyses, and the relative standard error of an estimate was examined to determine its reliability. If the relative standard error of any estimate was greater than 30%, the estimate was either not reported or flagged as unreliable. Nationally representative estimates for the number and prevalence of hospitalizations for persons with atrial fibrillation as either the principal diagnosis or 1 of up to 7 diagnoses were calculated by sex and year (1985 to 1999). The relative change in estimates over time was calculated as the 1999 estimate minus the 198 estimate divided by the 1985 estimate and multiplied by 100.

The age-standardized prevalence of hospitalization for atrial fibrillation as either the principal diagnosis or any diagnosis was estimated by sex for the years 1985 through 1999. Prevalence estimates were age standardized using the direct method for adjustment to the year 2000 standard population 35 years of age and older. The distribution of discharge status for hospitalizations with atrial fibrillation as any diagnosis was examined by sex from 1985 through 1999.

Results
The estimated number of hospitalizations and unadjusted prevalence (per 10,000 population) with atrial fibrillation as the principal or any diagnosis among adults, 35 years of age or older, by sex and year are shown in Table 1. Hospitalizations for atrial fibrillation as the principle diagnosis increased from 154,866 in 1985 to 376,487 in 1999 (144.3% relative change); in the same period, hospitalizations for atrial fibrillation as any of 7 diagnoses increased from 787,750 to 2,283,673 (189.9 relative change). Regardless of sex or year, approximately 1 in every 5 patients hospitalized with atrial fibrillation had atrial fibrillation listed as the principal diagnosis. Although women outnumbered men in the absolute number of hospitalizations, the unadjusted prevalence of hospitalizations did not differ notably by sex. In contrast, the age-standardized prevalence (ages 35 years or older) of hospitalizations for atrial fibrillation was consistently higher among men than women, with the difference greater for any diagnosis. The absolute male to female difference in the age-standardized prevalence (per 10,000) ranged from 2 (15–13) in 1986 to 6 (26–20) in 1994 for a principal diagnosis; for any diagnosis, it ranged from 17 (89–72) in 1986 to 50 (174–123) in 1996.

Figure 1 shows the age-specific prevalence of hospitalization for either a principal diagnosis or secondary diagnosis of atrial fibrillation for patients 35 years of age or older from 1985 through 1999. Regardless of year, the prevalence of hospitalizations for atrial fibrillation was higher among successive age groups. In persons age 35 to 54 years, there was only a modest increase over time in the prevalence of hospitalizations. In the older age groups, however, hospitalizations increased appreciably with temporal trends being most evident in the 1990s.

An examination of selected characteristics by sex of patients 35 years of age or older hospitalized with any diagnosis of atrial fibrillation in 1999 showed that women tended to be older and were more likely to have the government as the expected source of payment (Table 2). The regional distribution of atrial fibrillation hospitalizations did not vary much between men and women, with the highest percentage of hospitalizations occurring in the southern United States and the lowest percentage occurring in the western states (Table 2). For both sexes, length of stay was <1 week for 72% of hospitalizations (Table 2). Patients 35 to 54 years of age had a shorter length of stay (<3 days, data not shown).

Examination of these characteristic annually from 1985 through 1999 revealed no notable trend in the regional distribution of hospitalizations for either sex; a slight decrease was observed in the percentage of both men and women expected to use a government source of payment, with a corresponding increase in payment by private insurance, and the median length of stay decreased by 1 to 2 days in all age groups (data not shown). Most patients with atrial fibrillation from 1985 through 1999 were discharged home (Figure 2). Over time, however, the percentage of patients discharged home decreased for both sexes, with a corresponding increase in discharges to a long-term care setting.
care institution, a slight increase in discharges to a short-term facility, and almost no change for in-hospital mortality (Figure 2). Over the 15-year study interval, women were consistently more likely than men to be discharged to a long-term care institution.

In-hospital deaths were higher with a secondary diagnosis of atrial fibrillation (data not shown). For aggregate data from 1995 through 1999, stroke (ICD-9-CM 430), acute myocardial infarction (ICD-9-CM 410), and congestive heart failure (ICD-9-CM 428) were the 3 most frequent principal diagnoses for in-hospital fatalities among persons 65 years of age or older who had a secondary diagnosis of atrial fibrillation (data not shown).

The frequency of common comorbidities (as determined by their listing as 1 of 6 secondary diagnoses) among patients hospitalized in 1999 with a principal diagnosis of atrial fibrillation was examined by age group (35 to 64 versus ≥65 years) (Table 3). Essential hypertension and ischemic heart disease were the 2 prominent coexisting condition in both age groups, with the prevalence greater in the older patients (37% versus 47% and 18% versus 31%, respectively). Congestive heart failure was listed more often in older (21%) than younger (13%) patients, but diabetes was slightly more common in the younger group (16% versus 14%).

Among patients who were hospitalized in 1999 with atrial fibrillation as a secondary condition, congestive heart failure was the most frequent principal diagnosis for ages 35 to 64 years (11%) and 65 or older (13%). Chronic ischemic heart disease (ICD-9-CM 414), which was primarily coronary atherosclerosis, cardiac dysrhythmias (including atrial fibrillation and flutters [ICD-9-CM 427.3]), and acute myocardial infarction, were also common principal diagnoses for patients 35 to 64 years of age (10%, 7%, and 7%, respectively). In contrast, among patients 65

### Table 1. Atrial Fibrillation Hospitalizations and Prevalence (per 10 000 Population) Among Adults ≥35 Years of Age: National Hospital Discharge Survey, 1985 to 1999

<table>
<thead>
<tr>
<th>Year</th>
<th>Principal Diagnosis</th>
<th>Any Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men, No. (per 10 000)</td>
<td>Women, No. (per 10 000)</td>
</tr>
<tr>
<td>1985</td>
<td>66 608 (14.3)</td>
<td>85 478 (15.1)</td>
</tr>
<tr>
<td>1986</td>
<td>71 736 (14.7)</td>
<td>92 587 (16.1)</td>
</tr>
<tr>
<td>1987</td>
<td>76 774 (15.4)</td>
<td>86 310 (14.8)</td>
</tr>
<tr>
<td>1988</td>
<td>81 412 (16.0)</td>
<td>104 762 (17.6)</td>
</tr>
<tr>
<td>1989</td>
<td>78 048 (15.0)</td>
<td>98 924 (16.3)</td>
</tr>
<tr>
<td>1990</td>
<td>97 940 (18.3)</td>
<td>99 090 (16.1)</td>
</tr>
<tr>
<td>1991</td>
<td>105 541 (19.3)</td>
<td>124 739 (19.9)</td>
</tr>
<tr>
<td>1992</td>
<td>118 148 (21.1)</td>
<td>128 970 (20.1)</td>
</tr>
<tr>
<td>1993</td>
<td>117 957 (20.5)</td>
<td>142 637 (21.8)</td>
</tr>
<tr>
<td>1994</td>
<td>141 824 (24.2)</td>
<td>153 345 (23.0)</td>
</tr>
<tr>
<td>1995</td>
<td>139 545 (23.3)</td>
<td>156 172 (23.0)</td>
</tr>
<tr>
<td>1996</td>
<td>147 997 (24.1)</td>
<td>169 469 (24.5)</td>
</tr>
<tr>
<td>1997</td>
<td>156 677 (25.0)</td>
<td>187 480 (26.6)</td>
</tr>
<tr>
<td>1998</td>
<td>170 811 (26.7)</td>
<td>186 710 (26.0)</td>
</tr>
<tr>
<td>1999</td>
<td>167 364 (24.8)</td>
<td>209 123 (27.8)</td>
</tr>
</tbody>
</table>

Relative increase,* %

*1999 value minus 1985 value divided by 1985 value multiplied by 100.

Figure 1. Age-specific prevalence (per 10 000 population) of hospitalizations for atrial fibrillation among adults 35 years of age or older by year, 1985 to 1999.
years of age or older, pneumonia (ICD-9-CM 486) was the second among the principal diagnoses (7%), followed by acute myocardial infarction (6%). Atrial fibrillation and flutters was the principal diagnosis for 1% of patients.

**Discussion**

**Principal Findings**

Over one and a half decades (1985 through 1999) in the United States, hospitalization of patients with atrial fibrillation became much more prevalent, almost tripling in men and women. Although women were hospitalized more often than men on an annual basis, the age-standardized prevalence of hospitalizations was greater in men than women, particularly for any diagnosis with atrial fibrillation. Atrial fibrillation affects primarily persons 75 years of age or older (>50% of hospitalizations with this disorder for both sexes). Women hospitalized with atrial fibrillation tend to be older than men.

A study of trends in hospital activity related to atrial fibrillation in Scotland from 1986 through 1996 showed sex-specific patterns very similar to those presented in the present report. In that study, the investigators presented trends in both the number of hospitalizations and individual patients hospitalized. Repeat discharges within a calendar year increased from 6% in 1986 to 19% in 1996; this figure was rather constant in the 1980s but rose steadily from 1990 to 1996. Stewart et al pointed out that the increase in hospitalizations and persons hospitalized occurred most clearly after 1990 to 1991, which coincides with the publication of clinical trials demonstrating the efficacy of antithrombotic therapy in preventing stroke in persons with atrial fibrillation. The investigators suggest that these trends may have influenced hospital admissions and coding practice, especially secondary coding.

In the present investigation we found that most persons hospitalized with atrial fibrillation as either the principal or secondary diagnosis were discharged home with a decreasing trend over the study period, seen primarily in patients 75 years of age and older who had atrial fibrillation as a secondary diagnosis. Conversely, discharges to a long-term care institution increased from 1985 through 1999, primarily in older patients with a secondary diagnosis of atrial fibrillation. The fact that congestive heart failure was the most frequent principal diagnosis among patients hospitalized with atrial fibrillation as a secondary diagnosis may explain the high proportion of older patients discharged to long-term care. Data from NHDS published earlier show that among persons hospitalized with any diagnosis of heart failure from 1985 through 1995, the prevalence of discharge to long-term care increased among persons 75 years of age or older. We also found that women hospitalized with atrial fibrillation were more likely to be discharged to long-term care than their male counterparts. Unfortunately, from the NHDS data one cannot discern whether discharges to long-term care institutions are new admissions to nursing homes or readmissions to those facilities. Admission to a skilled nursing facility could also represent the absence of a spouse or the inability of offspring to provide home care, especially for older women.

In-hospital mortality among patients with a principal diagnosis of atrial fibrillation was relatively low but rather inconsistent.
TABLE 3. Comorbidities Among Adults ≥35 Years of Age Hospitalized in 1999 With Atrial Fibrillation: National Hospital Discharge Survey

<table>
<thead>
<tr>
<th>Diagnosis (ICD-9-CM)</th>
<th>Age 35 to 64 Years (n=99,440)*</th>
<th>Age ≥65 Years (n=277,047)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Essential hypertension (401)</td>
<td>36,357</td>
<td>36.6</td>
</tr>
<tr>
<td>Ischemic heart disease (410 to 414)</td>
<td>18,055</td>
<td>18.2</td>
</tr>
<tr>
<td>Congestive heart failure (428)</td>
<td>13,057</td>
<td>13.1</td>
</tr>
<tr>
<td>Other cardiac dysrhythmias (427)</td>
<td>16,161</td>
<td>16.3</td>
</tr>
<tr>
<td>Diabetes mellitus (250)</td>
<td>16,350</td>
<td>16.4</td>
</tr>
<tr>
<td>Chronic airway obstruction (496)</td>
<td>6,473</td>
<td>6.5</td>
</tr>
<tr>
<td>Valve disorders (424)</td>
<td>6,669</td>
<td>6.7</td>
</tr>
<tr>
<td>Postsurgical states†</td>
<td>9,600</td>
<td>9.7</td>
</tr>
<tr>
<td>Disorders of lipid metabolism (272)</td>
<td>10,082</td>
<td>10.1</td>
</tr>
</tbody>
</table>

*Data are for patients hospitalized with atrial fibrillation as the principal (first-listed) diagnosis.
†Cardiac pacemaker in situ, aortocoronary bypass, neuropacemaker (V450, V458).

over the 15-year study interval. On average, the proportion of case fatality was <1% in patients 35 to 74 years of age, 1.5% in those 75 to 84 years of age, and 3% in patients 85 years of age or older. These modest figures notwithstanding, the absolute number of deaths is still quite substantial, an unequivocal reminder that atrial fibrillation is not a benign condition. In contrast to hospital discharges for atrial fibrillation, data published elsewhere show that the overall number of discharges in the NHDS dropped considerably from 1985 through 1999, attributable in part to an increase in ambulatory or same-day surgery visits. This NCHS report also shows a decline in number of days of care observed in the NHDS, a result of both the drop in the number of inpatients and reduced length of stay for hospital inpatients. Considering the overall decline in discharges, the marked increase in hospitalization for atrial fibrillation is a particular public health concern, and this number is projected to increase to >3.8 and 5.6 million by the years 2025 and 2050, respectively. Novel treatment approaches, however, may significantly alter the prevalence and management of atrial fibrillation in the near future. In particular, surgical and catheter ablation techniques, implantable devices, and hybrid therapies all hold significant potential for abolishing atrial fibrillation, restoring sinus rhythm, and preventing cardiac and cerebral complications. In patients eligible for these novel therapies, the prevalence of recurrent atrial fibrillation and hospitalizations for symptoms and complications will be lower.

In summary, the epidemic of atrial fibrillation in the United States elderly can be attributed to both real and influential causes. The increase in atrial fibrillation prevalence is in part a consequence of an aging population and associated prevalence of congestive heart failure. The publication in 1990 to 1991 of clinical trials demonstrating the efficacy of antithrombotic therapy in preventing stroke in persons with atrial fibrillation also likely influenced hospital admissions and coding practice. Furthermore, we have seen an increase in its diagnosis through better use of ambulatory, long-term monitoring devices.

**Limitations**

Our study indicates that there were some 2.28 million hospitalizations of persons with atrial fibrillation in 1999. This estimate, however, does not represent the number of persons hospitalized nor the prevalence of atrial fibrillation cases. The NHDS may include multiple hospitalizations for cases readmitted, and the number of persons with atrial fibrillation who did not require hospitalization is unknown. Because the NHDS excluded Veteran Affairs or military hospitals from the study design, these results may underestimate nationwide hospitalizations with atrial fibrillation. Interestingly, Go et al estimated that there are presently nearly 2.3 million adults in the United States with atrial fibrillation, based on a study of adults 20 years of age or older who were enrolled in a large health care maintenance organization in California.

As mentioned above, in the NHDS data, one cannot discern whether discharges to long-term care institutions are new admissions to nursing homes or readmissions to those facilities.

**Clinical Implications**

Five randomized placebo-controlled clinical trials begun in the mid-1980s have demonstrated that long-term anticoagulation therapy with warfarin significantly reduced the risk of stroke in patients with nonrheumatic atrial fibrillation with almost no increase in major bleeding. Anticoagulation therapy has also been shown to be important for secondary prevention of stroke in patients with atrial fibrillation who have had a previous minor stroke or transient ischemic attack. For high-risk patients older than 75 years, close surveillance of warfarin use is needed because of the greater likelihood of bleeding. Although anticoagulation therapy is generally accepted for patients with atrial fibrillation, certain agents interact with warfarin and digoxin, and close observation is warranted when these drugs are used. Electrical conversion or initiation of antiarrhythmic drugs for conversion to sinus rhythm also requires hospitalization. These
recommended therapies may in part explain the temporal increase in hospitalizations of persons with atrial fibrillation. The optimal treatment strategy for patients with nonrheumatic atrial fibrillation is still being investigated. Examination of the cost effectiveness of antithrombotic and antiarrhythmic treatment strategies for atrial fibrillation, based on a hypothetical case, indicated that for asymptomatic patients, cardioversion followed by either aspirin or warfarin without subsequent antiarrhythmic therapy is the treatment of choice.36 Effectiveness was measured in quality of life years (QALYs), and this strategy yielded an additional 1.36 QALYs at a cost of $10,800 per additional QALY.37 Nevertheless, therapeutic strategies must be individualized, and generalizations to clinical practice must be made with caution.

The adverse trend in hospitalizations for atrial fibrillation in the context of an aging population and associated prevalence of congestive heart failure presages a staggering burden on the Medicare system and the quality of life for affected persons. Using anticoagulation therapy for the primary and secondary prevention of stroke in persons with atrial fibrillation is imperative. Secondary prevention of atrial fibrillation through the control and maintenance of normal cardiac rhythm is also important. Prevention of atrial fibrillation in the first place, through the identification of modifiable risk factors and their effective treatment and control, should be pursued as a complementary strategy for reducing the public health burden. The general public should also be educated about the signs and symptoms of atrial fibrillation and the need to seek medical treatment.

References
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