Prevalence of Atrial Fibrillation and Antithrombotic Prophylaxis in Emergency Department Patients

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Background and Purpose—The emergency department (ED), as the point of first medical contact for many complaints referable to atrial fibrillation (AF) and a common source of primary care, occupies a unique position to identify AF patients at risk of stroke. This study evaluates that potential by determining the prevalence of AF in an ED population and assessing antithrombotic use in those patients with recurrent AF.

Methods—This was a multicenter, retrospective, cross-sectional study of consecutive records of ED patients with AF identified by ECG between January and June 1998. American Heart Association and modified Stroke Prevention in Atrial Fibrillation criteria established high-risk patients and contraindications to anticoagulation, respectively.

Results—We identified 866 records with ECG-proven AF in 78,787 patient visits for an estimated prevalence of 1.10% (95% CI, 1.03 to 1.17). We found that 556 records had a prior history of AF; of these, 221 (40%) used warfarin alone, 155 (28%) had antiplatelet therapy alone, 28 (5%) used both, and 152 (27%) had no antithrombotic therapy identified. Sixty-eight patients (12%; 95% CI, 0.10 to 0.15) were warfarin eligible and without antithrombotic therapy. An additional 64 (12%; 95% CI, 0.09 to 0.14) had antiplatelet therapy alone. In warfarin-eligible patients, no differences were identified between the anticoagulated and nonanticoagulated groups on the basis of age, sex, or race. Of patients on warfarin with a measured international normalized ratio, 61% (95% CI, 0.55 to 0.67) were outside the AHA-recommended range of 2.0 to 3.0.

Conclusions—AF is a common finding in an ED population. Many are warfarin eligible and untreated or undertreated. Methods to increase anticoagulant use in this at-risk population warrant further investigation. (Stroke. 2002;33:2664-2669.)

Key Words: anticoagulants ■ atrial fibrillation ■ stroke prevention

Atrial fibrillation (AF) effects >2.2 million individuals and accounts for ~50,000 strokes annually in the United States.1,2 Results of pooled analyses of 5 randomized clinical trials demonstrate that anticoagulation in AF decreases the risk of ischemic stroke by 68% (95% CI, 50 to 79; P≤0.01) while increasing the risk of major hemorrhage 0.3% per year.3 Aspirin also reduces stroke risk in the setting of AF, although with a more modest 22% relative risk reduction (95% CI, 2 to 38) compared with placebo.4 Reflecting the magnitude of this risk reduction, numerous recommendations for anticoagulant therapy in AF have been issued since the early 1990s. Estimates suggest that full implementation of published guidelines could prevent 40,000 strokes annually.5,6 Nevertheless, warfarin use remains limited, with approximately half of eligible patients receiving treatment.7-9

The emergency department (ED) may represent an underused resource for improving anticoagulant use in patients with AF. EDs account for ~10% of all ambulatory medical care in the United States, with >102 million visits in 1999. Seventeen percent of visits were made by persons 45 to 64 years of age and 15% by individuals ≥65 years of age, important at-risk populations for AF.10 Additionally, the ED interacts with a population not reachable through other medical venues. A 1993 Governmental Accounting Office study found that 40% of patients treated in an ED lacked a usual source of health care.11 AF has been qualitatively described as the most frequently managed arrhythmia in the ED, although its prevalence in this setting has not been previously reported.12 Considering the association of AF with increasing age and the frequency of evaluating individuals without other healthcare access, the potential exists to identify substantial numbers of untreated AF patients at risk of ischemic stroke in the ED. The objective of this study was to assess this potential by estimating the prevalence of AF and the degree and type of antithrombotic use in a tertiary ED patient population.

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2664
New-onset AF was defined as any patient without a prior history of stroke and contraindications to anticoagulation to evaluate treatment also separated by the presence of a high-risk variable for ischemic antithrombotic use in patients with recurrent AF. These records were normalized ratio (INR), if measured; and disposition at discharge. Effective anticoagulation was defined as an INR of 2.0 and 3.0.

Figure 1. Overall prevalence of antithrombotic use, contraindications, and stroke risk. Dx indicates diagnosed; AP, antiplatelet therapy (aspirin or ticlopidine); CI, contraindications. * indicates 95% CIs were calculated with Fisher’s exact test.

Materials and Methods

Design and Study Population
A retrospective, cross-sectional study of consecutive ED patients with nonvalvular AF diagnosis by ECG between January 1 and June 30, 1998, at the University of Michigan (Ann Arbor), St Joseph Mercy Hospital (Ann Arbor), and the University of Cincinnati (Ohio). These EDs are associated with residency training programs and are regional trauma centers representing a mixture of both urban and suburban tertiary care facilities. The combined regional population served by these EDs have age, sex, and race profiles similar to those of the overall US population, except for a lower proportion of patients of Hispanic origin. The Institutional Review Boards of the University of Michigan and University of Cincinnati approved the study for conduct under institutional consent forms. All adult patients evaluated in the ED and undergoing ECG analysis during the study period were eligible for inclusion. Each department used dedicated ECG equipment with computer rhythm interpretation stored in a searchable database. Patients with AF were identified from each database with subsequent rhythm confirmation. Using available medical records, a study physician or clinical nurse coordinator completed a 40-item data form for each patient visit. Information sought included patient demographics; past medical history; contraindications to antithrombotic therapy; medications at ED presentation with specific evaluation for warfarin, aspirin, ticlopidine, and/or clopidogrel use; treatment in the ED; international normalized ratio (INR), if measured; and disposition at discharge. Patients with multiple ECG tracings over the study period were recorded as separate incidences if obtained on different visit dates, each representing a separate opportunity for identifying antithrombotic therapy need. The total number of adult patient visits during the study period formed the denominator for determination of the prevalence of AF. Effective anticoagulation was defined as an INR ≥2.0 and ≤3.0.

Patient with new-onset AF or those with a history of hyperthyroidism or a prosthetic cardiac valve were excluded to evaluate antithrombotic use in patients with recurrent AF. These records were also separated by the presence of a high-risk variable for ischemic stroke and contraindications to anticoagulation to evaluate treatment in the groups defined as warfarin-eligible and warfarin-ineligible. New-onset AF was defined as any patient without a prior history of AF, as documented by the treating physician, or prior documented AF in the ECG database.

Patients were considered at high risk for stroke on the basis of recommendations published by the American Heart Association. High risk was defined as the presence of any of the following variables in the medical record at the time of ED presentation: prior diagnosis of hypertension, previous stroke or transient ischemic attack, diabetes mellitus, congestive heart failure, or age >65 years.3,13,14

We adapted the Stroke Prevention in Atrial Fibrillation (SPAF) trial exclusion criteria for determining contraindications to anticoagulant therapy in a method similar to that of Sudlow et al.9 These were defined as the following: (1) any current gastrointestinal or genitourinary bleeding or any prior gastrointestinal or genitourinary hemorrhage requiring hospitalization, transfusion, surgery, or emergent endoscopy; (2) inability to monitor patient, including identification as homeless within the medical record, lack of a registration home address, or as determined by the chart reviewer; (3) the presence of liver disease as determined by documented history or clinical suspicion of regular daily intake of large amounts of alcohol, regular heavy drinking of alcohol limited to weekends, periods of sobriety punctuated by binges lasting weeks to months, or known cirrhosis of any cause; (4) any central nervous system hemorrhage, hematoma, or bleeding complication requiring hospitalization; (5) history of ≥3 falls in the preceding year, patients with known ataxia or vertigo, and patients requiring crutches, cane, walker, or assistance to ambulate or judged unstable by chart reviewer; (6) the presence of uncontrolled hypertension defined as systolic pressure >180 mm Hg or diastolic pressure >100 mm Hg; or (7) daily use of nonsteroidal anti-inflammatory drugs.6,15

Statistical Analysis
Continuous variables are presented as mean±SD; categorical variables are given as proportions with 95% CIs. Period prevalence of untreated AF is presented as a proportion with 95% CIs. Qualitative data were compared by use of a χ² test, with P≤0.05 considered significant. No comparison of data between hospitals was conducted because 2 (University of Michigan and St Joseph Mercy Hospital) share a common service area with the potential of confounding.
TABLE 1. Baseline Characteristics of ED Patients With Recurrent AF

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (±SD), y</td>
<td>74.5 (±12.9)</td>
<td></td>
</tr>
<tr>
<td>Age group, n</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;55 y</td>
<td>44</td>
<td>8</td>
</tr>
<tr>
<td>55–64 y</td>
<td>67</td>
<td>12</td>
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<tr>
<td>65–74 y</td>
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<td>24</td>
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<tr>
<td>75–84 y</td>
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<td>38</td>
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<tr>
<td>≥85 y</td>
<td>100</td>
<td>18</td>
</tr>
<tr>
<td>Male/female, n</td>
<td>240/316</td>
<td>43/57</td>
</tr>
<tr>
<td>Ethnic background</td>
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<td></td>
</tr>
<tr>
<td>White</td>
<td>474</td>
<td>85</td>
</tr>
<tr>
<td>Black</td>
<td>63</td>
<td>11</td>
</tr>
<tr>
<td>Asian</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>Other</td>
<td>18</td>
<td>3.2</td>
</tr>
<tr>
<td>High-risk stroke variable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age &gt;65 y</td>
<td>441</td>
<td>79</td>
</tr>
<tr>
<td>Hypertension</td>
<td>329</td>
<td>59</td>
</tr>
<tr>
<td>CHF</td>
<td>245</td>
<td>44</td>
</tr>
<tr>
<td>Diabetes</td>
<td>129</td>
<td>23</td>
</tr>
<tr>
<td>Prior stroke or TIA</td>
<td>125</td>
<td>23</td>
</tr>
<tr>
<td>Coronary heart disease</td>
<td>230</td>
<td>41</td>
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<tr>
<td>ED disposition</td>
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<td></td>
</tr>
<tr>
<td>Hospital admission</td>
<td>422</td>
<td>76</td>
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<tr>
<td>Discharged from ED</td>
<td>134</td>
<td>24</td>
</tr>
</tbody>
</table>

CHF indicates congestive heart failure; TIA, transient ischemic attack.

Results

During the study period, 78,787 emergency patient visits occurred. A total of 15,238 ECGs were obtained (Figure 1); 871 identified AF in patients ≥18 years of age. Of these records, 866 were available for review (University of Michigan, 219; St Joseph Mercy Hospital, 495; University of Cincinnati, 152). The estimated prevalence of AF in the overall ED population was 1.10% (95% CI, 1.03 to 1.17). Among patients undergoing ECG evaluation, the prevalence of AF was 5.68% (95% CI, 5.32 to 6.05).

Of the 866 reviewed records, 310 were excluded from further analysis by a history of new-onset AF, hyperthyroidism, or valvular heart disease, leaving 556 records in the study population with recurrent AF. These 556 records represented 478 individual patients because 63 patients had multiple visits during the study period. All data forms had complete demographic information.

Patient Characteristics

In the study population, the mean ± SD age was 74.5 ± 12.9 years (median, 77.4). Baseline characteristics are identified in Table 1. The presence of a high-risk variable for stroke was identified in 94% of records, with age >65 years being most frequently identified. Patients with multiple risks were common: 33% of all records had 2 high-risk variables, 28% had 3, and 14% had ≥4. A contraindication to warfarin use was identified in 240 records, with 74% having a single contraindication, 21% with 2 contraindications, and 5% with ≥3 contraindications noted. The most frequent contraindication noted was history of falling or unstable gait (n = 128).

Antithrombotic Use

The prevalence of antithrombotic use in ED patients with recurrent, nonvalvular AF is presented in Figure 1. Two hundred forty-nine records identified warfarin use. Two hundred twenty-one used warfarin alone, whereas 27 patients combined warfarin and aspirin therapy and 1 patient combined warfarin and ticlopidine. No use of clopidogrel was identified. Of the 249, 216 (87%) documented an INR value. Forty-four percent (95% CI, 0.38 to 0.51) were subtherapeutic, 37% (95% CI, 0.30 to 0.43) were within the recommended range, and 19% (95% CI, 0.14 to 0.24) had values >3.0.

In the 307 records without warfarin prophylaxis, the absence of antiplatelet therapy was as common as its use. In those patients on antiplatelet therapy alone, aspirin was again the dominant choice, with only 7 patients using ticlopidine. No instance of combining antiplatelet agents was found.

Contraindications to anticoagulation were common; the frequency by group is listed in Figure 1. Of the 249 warfarin-treated patients, 81 had modified SPAF exclusion criteria. Of the 307 nonanticoagulated patients, a contraindication was found in 159. The frequencies of individual modified SPAF contraindications to anticoagulation in each group are presented in Table 2. Nonanticoagulated patients were more likely to have a contraindication compared with patients on warfarin (P < 0.05).

“Warfarin eligible” was defined as the presence of recurrent AF, no identified SPAF contraindication to warfarin use, and an accompanying high-risk variable for ischemic stroke. Prevalence of antithrombotic use in this group is presented in Figure 2. Of the 291 warfarin-eligible patients, 159 (55%) had warfarin (or warfarin plus antiplatelet) therapy identified, 64 (22%; 95% CI, 0.17 to 0.27) noted antiplatelet use alone, and 68 (23%; 95% CI, 0.19 to 0.28) lacked evidence of any stroke prevention therapy.
The prevalence of AF in the overall ED population (1.10%; 95% CI, 1.03 to 1.17) was significantly higher than the 0.95%....

**Figure 2.** Antithrombotic use in warfarin-eligible and -ineligible populations. AP indicates antiplatelet therapy (aspirin or ticlopidine). *indicates 95% CIs calculated with Fisher’s exact test.

![Table 2](http://stroke.ahajournals.org/)

<table>
<thead>
<tr>
<th>Warfarin-eligible</th>
<th>Warfarin + AP</th>
<th>AP alone</th>
<th>Neither</th>
</tr>
</thead>
<tbody>
<tr>
<td>281 (52%)</td>
<td>15 (5%)</td>
<td>64 (22%)</td>
<td>60 (23%)</td>
</tr>
<tr>
<td>[0.48, 0.56]</td>
<td>[0.03, 0.10]*</td>
<td>[0.17, 0.27]</td>
<td>[0.19, 0.29]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Warfarin-eligible</th>
<th>Warfarin + AP</th>
<th>AP alone</th>
<th>Neither</th>
</tr>
</thead>
<tbody>
<tr>
<td>265 (48%)</td>
<td>13 (5%)</td>
<td>91 (34%)</td>
<td>64 (32%)</td>
</tr>
<tr>
<td>[0.44, 0.52]</td>
<td>[0.03, 0.11]*</td>
<td>[0.29, 0.40]</td>
<td>[0.26, 0.37]</td>
</tr>
</tbody>
</table>

Among the 159 anticoagulated, warfarin-eligible patients, women outnumbered men 94 to 65 (59% to 41%), with whites accounting for 140 (88%). By age groups, 13 (8%) were <55 years of age, 23 (15%) were 55 to 64 years of age, 51 (32%) were 65 to 74 years of age, 52 (33%) were 75 to 84 years of age, and 20 (13%) were ≥85 years of age. In the 132 nonanticoagulated, warfarin-eligible patients, women also outnumbered men 80 to 52 (61% to 39%), with 112 (85%) identified as white. Evaluated by age, 11 patients (8%) were <55 years of age, 11 (8%) were between 55 and 64 years of age, 39 (30%) were between 65 and 74 years of age, 50 (38%) were between 75 and 84 years of age, and 21 (16%) were ≥85 years of age. No significant differences were identified for sex, race, or any age subgroup between anticoagulated and nonanticoagulated, warfarin-eligible populations (χ², P>0.05).

High-risk variables in the nonanticoagulated, warfarin-eligible population were age ≥65 years, 110 (83%); hypertension, 93 (70%); congestive heart failure, 57 (43%); diabetes mellitus, 32 (24%); and prior stroke or transient ischemic attack, 19 (14%). Multiple risk factors were identified in 106 cases. Of the 132 records, 102 (77%) indicated hospital admission after ED evaluation. This finding did not differ significantly from admission rates for the overall study population.

Of the 265 identified as ineligible for warfarin, 90 (34%) were anticoagulated. Among this group, women outnumbered men 47 to 43 (52% to 48%), and 78 (87%) were white. The mean age for this group was 72 years. In the remaining 175 patients, women outnumbered men 95 to 80 (51% to 46%), with 144 whites (82%). The mean age was 76 years. No significant differences were identified for sex, race, or any age subgroup between anticoagulated and nonanticoagulated, warfarin-ineligible populations (χ², P>0.05). Eighty-four (32%) had no antiplatelet therapy, and 13 (5%) were on both anticoagulant and antiplatelet drugs.

Antithrombotic intervention while the patient was in the ED was infrequent. Of the 556 patients in the base population, 84 (15%) received aspirin, 52 (9%) received heparin, and 1 (0%) was started on warfarin.

**Discussion**

**Overview**

The US population with AF is expected to rise from the current estimate of 2.2 million individuals to 5.6 million by 2050.16 Given an approximate 3% to 5% per year rate of ischemic stroke in unselected patients with nonvalvular AF,17 it is clear that the burden of stroke caused by AF will increase if prevention efforts are not successful. The effectiveness of anticoagulation in this role is well established, and numerous guidelines advocate its use.14,18,19 Nevertheless, substantial underuse occurs in both the inpatient6,8 and community20 settings, and numerous authors have called for coordinated efforts to improve treatment.21

Efforts to improve anticoagulant use have focused on professional and public education,22 governmental monitoring, and reducing barriers to treatment. These efforts, however, may be limited by the number of physicians requiring educational contact, patient access to primary care, prevalence of AF in a given practice population, and the effectiveness of physician interventions to increase antithrombotic use. Additional approaches are needed to increase treatment and monitor therapy.

The literature on improving medical treatment supports a “multilevel” approach to decreasing morbidity and mortality from cardiovascular disease and stroke. These strategies focus on improving patient, provider, and health system behaviors to increase compliance.23 The ED occupies a logical position to implement such strategies in the context of improving anticoagulation in AF because it continuously interfaces with all 3 elements. Additionally, it may offer unique advantages in that it is often the point of first medical contact for patients with complaints referable to AF, including chest pain, palpitations, and shortness of breath. This may represent a “teachable moment” when patients and/or referring physicians are most receptive to behavioral and medical intervention for stroke prevention or health maintenance.24 Additionally, EDs serve as the primary healthcare resource to many of the 43 million uninsured in the United States and see a disproportionate percentage of low-income families and minorities.25

Our study represents a first step in evaluating the potential impact of including the ED in stroke prevention efforts in AF. In addition to determining the prevalence of AF in this setting, the results extend previous findings of anticoagulation underuse to ED patients in a tertiary setting and indicate a serious lack of effective anticoagulation in those already on warfarin therapy.

**Prevalence of AF in the ED**

The prevalence of AF in the overall ED population (1.10%; 95% CI, 1.03 to 1.17) was significantly higher than the 0.95%...
(95% CI, 0.94 to 0.96) reported in a study of 1.98 million members of a health maintenance organization. It is also larger than the 0.89% reported for the overall US population. This likely reflects an increased frequency of cardiovascular disease in patients presenting for emergency care. Importantly, our methodology identified cases only in those undergoing routine ECG analysis and likely represents a conservative estimate of the true prevalence of AF in the entire ED population.

The 5.7% (95% CI, 5.3 to 6.0) prevalence of AF in the population of patients undergoing ECG testing (n=15,238) matches the upper range of the 4.7% to 6.0% prevalence reported for populations ≥65 years of age.1,9,26 This finding is not unexpected because 80% of records reviewed identified patients ≥65 years of age, again reflecting the frequency of ED evaluation of cardiovascular and pulmonary complaints in the elderly.

**Warfarin Use**

In our study population, warfarin was underused in eligible patients. Of the 291 records identified as warfarin-eligible patients, 132 indicated no anticoagulant use. Of these, half noted antiplatelet use alone, and the remainder had no antithrombotic therapy of any kind. The size of the treatment effect from placing these patients on warfarin can be estimated with previously published data.4 Anticoagulation of the 68 warfarin-eligible patients on no antithrombotic therapy would have prevented 2.5 primary ischemic strokes per year, assuming a relative risk reduction of 60%. Anticoagulation of the 64 warfarin-eligible patients on aspirin would have prevented 1.5 primary ischemic strokes per year, assuming a relative risk reduction of 40%.4 Thus, over the 6-month study period, an effective intervention to increase anticoagulant use in at-risk patients could potentially have prevented 4 strokes per year (number needed to treat to prevent 1 stroke; 33). To achieve similar results with intravenous recombinant tissue plasminogen activator (Activase or alteplase) after an acute stroke would require treatment of 36 patients within 3 hours (number needed to treat to achieve a National Institutes of Health Stroke Scale score of 0 to 1, 9). This number exceeds the annual thrombolytic treatment figures reported by many acute stroke teams and metropolitan areas.27–29 Of note, one quarter of the untreated, eligible patients in our study were discharged home from the ED, often without antithrombotic therapy.

Additional increases in the total proportion of patients eligible for anticoagulation and therefore the effect of an intervention may be possible on the basis of recent data suggesting the SPAF exclusion criteria are too restrictive. In 1999, Man-Son-Hing et al30 published a Markov decision analysis to determine the preferred antithrombotic treatment in patients with AF who were ≥65 years of age and at risk for falling who had no other contraindications to antithrombotic therapy. Their analysis demonstrated that the risk of falling was not an important factor in excluding AF patients at risk for stroke. Recalculation of the warfarin-eligible population in our study based on their results, i.e., without using a history of falls or unstable gait as an exclusion criteria, increased the total number of patients eligible for anticoagulant therapy from 291 (52%; 95% CI, 0.48 to 0.56) to 365 (66%; 95% CI, 0.62 to 0.70). These figures are supported by the assessment of Sudlow et al30 of warfarin eligibility in a random sample of >4000 individuals in a UK community. That study found that 61% (95% CI, 0.53 to 0.69) of patients with AF were eligible for anticoagulation on the basis of SPAF-defined inclusion/exclusion criteria alone.

We also identified numerous cases in which warfarin was used in ineligible patients. In the 265 cases ineligible for warfarin because of a lack of a high-risk stroke variable or the presence of a modified SPAF contraindication, 90 (16%; 95% CI, 0.13 to 0.19) were anticoagulated. This may represent inappropriate treatment or treatment of patients with reversible contraindications to anticoagulation. Evaluation of the specific contraindications in these 90 patients found 14 on chronic nonsteroidal anti-inflammatory drug therapy and 7 with hypertension, both modifiable conditions.

In our study population, effective anticoagulation (INR between 2.0 and 3.0) to prevent stroke in AF was the exception in patients already on warfarin therapy. Only one third of patients tested were within recommended guidelines, a finding identical to previous reports on INR values at admission in hospitalized patients with AF.4 This may reflect an alteration in a previously therapeutic INR because of the underlying condition requiring the patient to seek hospital-based care or a broader failure in monitoring and maintaining effective anticoagulation. In either case, the risk-to-benefit ratio of warfarin therapy is negatively affected, and increased INR testing in the ED is recommended.

Limitations of this study include those associated with its retrospective design. We relied on identifying patients only through ECG tracings with documented AF. This may have excluded patients with AF who did not undergo ECG analysis. We were dependent on the accuracy and availability of hospital medical records for the quality of the variables studied. No attempt was made to obtain information directly from the patient or the primary care physician to supplement the available information. Patient refusal of offered anticoagulation therapy was not evaluated, nor was compliance with a recommended treatment program.

In conclusion, a substantial percentage of untreated patients with recurrent AF who are eligible for anticoagulation can potentially be identified in the ED setting. Routine assessment of INR of anticoagulated AF patients is recommended because subtherapeutic and supratherapeutic INR results are common. These findings support further evaluation of the use of EDs in stroke prevention efforts for patients with AF. Methods to prospectively identify, refer, and/or treat AF patients with high-risk variables for ischemic stroke should undergo further exploration in the ED setting.

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Prevalence of Atrial Fibrillation and Antithrombotic Prophylaxis in Emergency Department Patients

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