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## Emergency Department, Hospital Inpatient, and Mortality Burden of Atrial Fibrillation in the United States, 2006–2014

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### Abstract

The prevalence of atrial fibrillation (AF) is increasing in the United States as the population ages, but national surveillance is lacking. This cross-sectional study (2006–2014) analyzed data from the Healthcare Cost and Utilization Project's Nationwide ED Sample, the Nationwide/National Inpatient Sample, and the National Vital Statistics System. Event totals were estimated independently for ED visits, hospitalizations, and mortality, and then collectively after applying criteria to identify mutually exclusive events. Rates were calculated for AF as primary diagnosis/underlying cause of death (primary AF) as well as secondary diagnosis/contributing cause of death (comorbid AF), and standardized by age to the 2010 US population. From 2006–2014, event rates increased for primary AF (249 to 268 per 100,000) and comorbid AF (1,473 to 1,835 per 100,000). In 2014, an estimated 599,790 ED visits, 453,060 hospitalizations, and 21,712 deaths listed AF as primary. A total of 684,470 mutually exclusive primary AF and 4,695,997 mutually exclusive comorbid AF events occurred. Among ED visits and hospitalizations with primary AF, the most common secondary diagnoses were hypertension, heart failure, ischemic heart disease, and diabetes. The mean cost per hospitalization with primary AF was \$8,819. Mean costs were higher for those with comorbid AF vs. those without among hospitalizations with a primary diagnosis of ischemic heart disease, heart failure, stroke, hypertension, or diabetes (all  $p < 0.01$ ). In conclusion, with substantial health and economic impact of AF and an aging US population, improved diagnosis, prevention, management, and surveillance of AF is increasingly important.

### Keywords

atrial fibrillation; hospitalization; mortality

### Introduction

Patients with atrial fibrillation and flutter (AF) have increased risk of stroke and myocardial infarction,<sup>1</sup> cardiovascular hospitalization,<sup>2</sup> and mortality.<sup>2–5</sup> Despite increasing prevalence<sup>6,7</sup> and substantial health and economic impact,<sup>1–5,7–10</sup> there is no national surveillance system to track the magnitude of AF-related healthcare and mortality burden

across all ages and health insurance provider types.<sup>11</sup> This study aimed to overcome surveillance gaps by using national Healthcare Cost and Utilization Project (HCUP) and National Vital Statistics System data from 2006–2014 to describe the burden of AF-related emergency department (ED) visits, inpatient hospitalizations and costs, and mortality. In addition, we examined the burden of comorbid condition events in which AF is listed as a secondary cause and might play a contributing role.

## Methods

This cross-sectional study analyzed encounter-level data from 2006–2014 from the HCUP Nationwide Emergency Department Sample (NEDS) and the National (Nationwide) Inpatient Sample (NIS) to examine ED and hospitalization burden, respectively. The NEDS is the largest all-payer ED database in the US, with data from approximately 30 million discharges yearly that are weighted to produce national ED event estimates.<sup>12</sup> Data, from approximately 950 hospitals in 30 states, approximate a 20% stratified sample of US hospital-based EDs. The NIS is the largest all-payer inpatient healthcare database in the US that is publicly available, containing data from over 7 million hospitalizations yearly that are weighted to produce national hospitalization event estimates. The NIS approximates a 20% stratified sample of discharges from community hospitals in the US.<sup>13</sup> Because the NIS was re-designed in 2012, we used trend weights developed by the Agency for Healthcare Research and Quality (AHRQ) to make estimates comparable for data prior to 2012. National Vital Statistics System (NVSS) data from 2006–2014 were used to examine death events. The NVSS collects information reported on all death certificates filed in every US state and the District of Columbia.<sup>14</sup> All events for adults aged ≥ 18 years were included.

Atrial fibrillation and atrial flutter were examined jointly (referred to as AF throughout) using International Classification of Disease (ICD)-9 Clinical Modification code 427.3x (NEDS and NIS) and ICD-10 code I48 (NVSS). Events were analyzed for AF as primary diagnosis/underlying cause of death (primary AF) and for AF as a secondary diagnosis/contributing cause of death (comorbid AF). Comorbid conditions of interest were selected based on associations with AF in the literature, and included chronic kidney disease (CKD); diabetes; dementia or Alzheimer's (grouped together as "dementia"); heart failure, valvular heart disease, or cardiomyopathy (grouped together as "HF"); hypertension; ischemic heart disease (IHD); and stroke (including ischemic and hemorrhagic).<sup>1</sup> The AHRQ Clinical Classification Software codes were adapted to identify ICD-9 CM and ICD-10 codes for these conditions (Supplemental Table 1).

Event totals were estimated independently for ED visits, hospitalizations, and deaths, and then collectively after applying criteria to identify mutually exclusive events. To estimate mutually exclusive events, we excluded ED visits that resulted in hospitalization, transfer to another hospital, or death, and we excluded hospitalizations that resulted in transfers to another hospital or death.<sup>15</sup> Events were then summed across datasets. Event rates were calculated using intercensal population estimates as the denominators,<sup>16,17</sup> and were standardized by age to the 2010 US population. Hospitalization costs for inpatient stays were estimated from total charges by applying hospital-level cost-to-charge ratio data from HCUP. Cost-to-charge ratios were not available in NEDS, so costs could not be estimated

from ED visit charges. For statistical comparisons, t-tests were used for continuous variables and chi-square tests for categorical variables, and tests were 2-sided. Analyses were conducted using SAS 9.3-callable SUDDAN (Research Triangle Institute, Research Triangle Park, NC) to account for multistage, disproportionate stratified sampling design in the NEDS and NIS. All data were de-identified and publicly available, therefore this study was exempt from Institutional Review Board approval.

## Results

In 2014, approximately 600,000 (0.5% of all) ED visits, 450,000 (1.5% of all) hospitalizations, and 22,000 (0.8% of all) deaths listed AF as the primary cause (Table 1). About two thirds of ED visits and hospitalizations with primary AF occurred among Medicare beneficiaries. Among ED visits and hospitalizations with primary AF, the most common secondary diagnoses were hypertension, HF, IHD, and diabetes. As expected, these cardiometabolic conditions occurred more often in ED visits and hospitalizations with AF compared to without AF (all  $p < 0.001$ ). Among deaths with AF as the underlying cause, the most common contributing causes were HF and stroke.

Approximately 4 million (3.6% of all) ED visits, 3.5 million (12.0% of all) hospitalizations, and 100,000 (4.5% of all) deaths listed comorbid AF in 2014 (Table 2). Similar age and sex patterns were observed for events with comorbid AF compared to events with primary AF. Over 80% of ED visits and hospitalizations with comorbid AF occurred among Medicare beneficiaries. For ED visits and hospitalizations with AF as a secondary diagnosis, the most common primary diagnoses were HF, IHD, and stroke, among our conditions of interest. These primary diagnoses were more common among ED visits and hospitalizations with AF as a secondary diagnosis than without (all  $p < 0.001$ ). Among deaths with AF as a contributing cause, the most common underlying cause was IHD (21.9%).

Nearly 700,000 mutually exclusive events occurred with AF as the primary cause in 2014 (268 per 100,000), while nearly 4.7 million mutually exclusive comorbid AF events occurred (1,835 per 100,000) (Table 3). From 2006 to 2014, the primary AF event rate increased 8% from 249 to 268 per 100,000, while the comorbid AF event rate increased 25% from 1,473 to 1,835 per 100,000, respectively, after age-standardization to the 2010 US population (Figure 1, and detailed results available in Supplemental Tables 2 and 3). Crude rates of primary AF tended to be highest in the oldest women, whereas crude rates of comorbid AF were highest in the oldest men.

Almost two thirds (62.5%) of ED visits with primary AF resulted in admission to the hospital or transfer to another facility (vs 17.9% of ED visits without AF,  $p < 0.001$ ), and the mean total charge of ED visits for primary AF was approximately \$4,000 (Table 4). The estimated mean cost per hospitalization with primary AF was approximately \$8,800, with a mean length of stay of 3.5 days. Mean costs were significantly higher for those with comorbid AF vs. those without AF among hospitalizations with a primary diagnosis of hypertension (34% greater cost), IHD (32% greater cost), diabetes (29% greater cost), HF (19% greater cost), or stroke (3% greater cost). However, hospitalizations costs with

comorbid AF and a primary diagnosis of CKD or dementia were not significantly different from those without AF.

## Discussion

The healthcare and mortality burden of AF in the United States is substantial, and prevalence is increasing.<sup>18,19</sup> In 2014, almost 700,000 mutually exclusive primary AF events (ED visits, hospitalizations, and deaths) and nearly 4.7 million comorbid AF events occurred, and event rates increased during 2006–2014. Among hospitalizations with primary AF, cardiovascular secondary diagnoses were common, especially hypertension (over 2 of every 3), HF (nearly 1 of every 2), IHD (around 1 of every 3), and diabetes (around 1 of every 4). Hospitalization costs were higher for those with comorbid AF vs. those without AF for patients with a primary diagnosis of IHD, HF, stroke, hypertension, or diabetes.

Our estimates of increasing AF burden in the US are consistent with other research. Two Medicare studies, from 1992–2002 and 1993–2007, observed stable incidence rates for AF but increasing prevalence among persons aged ≥65.<sup>18,19</sup> Using NIS data, Patel *et al.* found that the AF hospitalization rate increased by 14.4% from 2000–2010,<sup>20</sup> while Freeman *et al.* observed a more modest increase among Medicare beneficiaries.<sup>21</sup> Given the strong association between AF incidence and age, it is expected that an aging population would contribute to increases in AF events.<sup>1,22</sup> However, we also observed increases in AF event rates after age-standardization to the 2010 US population, and age-standardized increases in prevalence have been reported.<sup>22,23</sup> Increases in AF might also be due to increased awareness and diagnosis,<sup>24</sup> including technological advances in detection devices and the ability to detect AF by interrogating pacemakers.<sup>25</sup>

Risk factors for AF may also be contributing to changes in AF burden.<sup>1,22</sup> Some, such as hypertension, diabetes, and smoking, may be antecedents of AF, while others, such as HF, stroke, myocardial infarction, and valvular disease, may be both risk factors for AF and clinical sequelae of AF.<sup>22,26</sup> Although prevalence of certain risk factors, such as smoking, are improving in the population, others have worsened.<sup>24</sup> For example, higher body mass index increases AF risk,<sup>22,27</sup> indicating that increases in obesity prevalence in recent decades may have contributed to increased AF burden.<sup>24</sup>

The substantial burden of AF has important cost implications. In 2001, 44% of direct costs of AF were attributable to primary AF hospitalizations.<sup>28</sup> We estimated the mean cost per hospitalization with AF as primary diagnosis at \$8,819 in 2014, which was similar to the 2010 cost.<sup>20</sup> Although length of hospitalization did not increase, mean hospitalization cost increased by 24% between 2000–2010, after adjusting for inflation.<sup>20</sup> Increasing hospitalization costs may be due to increased costs of clinical services overall,<sup>29</sup> the shifting of less costly AF care to an outpatient setting, or use of more sophisticated services, such as ablation therapy.<sup>30</sup> Of note, increased costs for AF have occurred simultaneously with decreases in inpatient mortality and AF readmission.<sup>21</sup>

In addition to the costs of primary AF, events in which AF might play a contributing role also have substantial costs, and were estimated to account for 29% of US spending on AF

treatment.<sup>22</sup> We observed a larger increase in comorbid AF event rate (25%) than primary AF event rate (8%) between 2006–2014, and costs were generally higher for comorbid than primary AF hospitalizations. Consistent with prior work,<sup>31</sup> we observed greater costs for events with comorbid AF compared to without. AF may exacerbate other cardiovascular conditions and increase severity of CVD events, leading to greater costs. For example, strokes with AF are often more severe, with longer hospitalizations, greater disability, and greater likelihood of mortality.<sup>32,33</sup>

This study was strengthened by the use of large, all-payer datasets, weighted to represent the US population. However, there were limitations. First, burden estimates did not capture treatment of AF in outpatient settings. Second, NEDS and NIS capture event-level data, not patient-level data, so patient factors (such as yearly per-patient costs and readmission rates) could not be explored. Third, this study does not describe costs of AF, but rather the cost of hospitalizations among those with AF. Fourth, burden estimates were dependent on accurate coding of AF and comorbidities, and biases may have resulted from changes in coding patterns over time, or underreporting of AF (particularly asymptomatic AF). Also, US death records are subject to misclassification, and, for example, deaths classified as primary AF may have had other underlying causes. Fifth, AF is a heterogeneous condition, and this study was not able to distinguish between sub-types of AF, from transient episodes to permanent arrhythmia.

This study of ED visits, hospitalizations, and mortality showed a substantial and increasing burden of AF. The US prevalence of AF is projected to rise from an estimated 5.2 million in 2010 to 12.1 million in 2030.<sup>6</sup> The majority of the burden of care for AF patients will impact Medicare, as approximately two thirds of ED visits and hospitalizations with primary AF, and over 80% of ED visits and hospitalizations with comorbid AF, occurred among Medicare beneficiaries. As the population ages and health care costs continue to rise, improved AF diagnosis, prevention, and management, as well as surveillance of burden, will be increasingly important.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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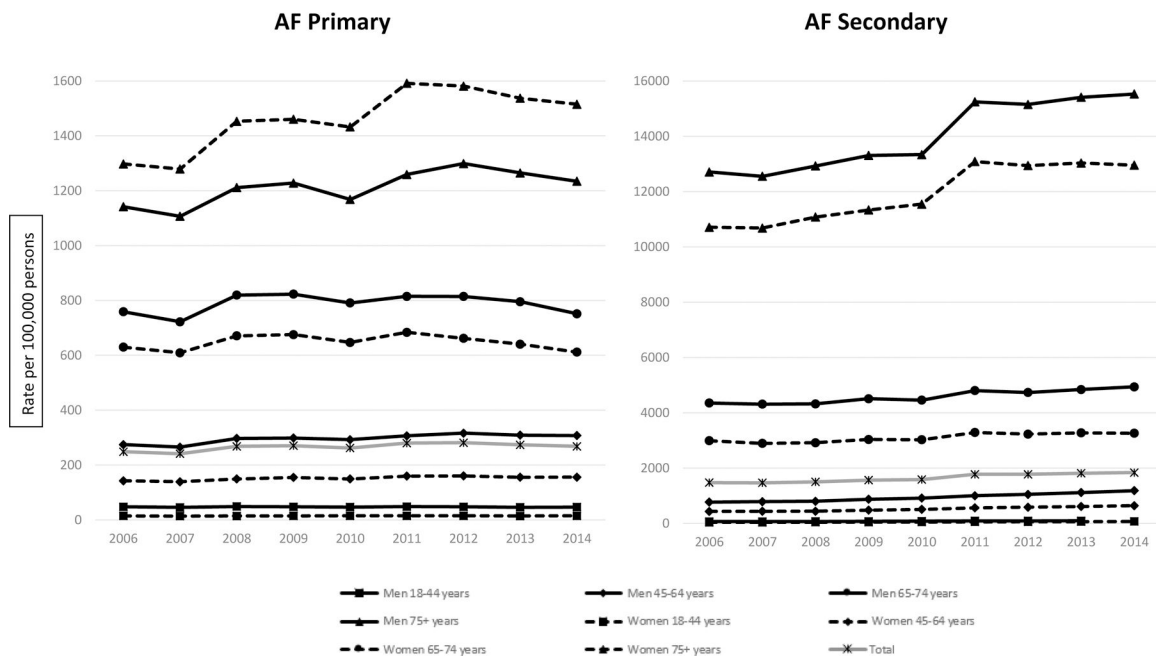
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**Figure 1: Trends in overall mutually exclusive atrial fibrillation or flutter events, by age group and primary versus secondary cause – Nationwide Emergency Department Sample, National (Nationwide) Inpatient Sample and National Vital Statistics System, 2006–2014**

Rate totals standardized by age to the 2010 U.S. Census Population distribution among adults aged 18 years. Crude age-sex specific rates were reported for subgroup estimates. Includes combination of emergency department encounters, hospitalizations, and deaths. AF = atrial fibrillation and flutter. See Supplemental Tables 2 and 3 for detailed numeric results.

Characteristics of patients age 18 years with atrial fibrillation or flutter as the primary diagnoses – Nationwide Emergency Department Sample 2014, National Inpatient Sample 2014 and National Vital Statistics System 2014

**Table 1.**

Variable	Emergency Department Visits		Hospitalizations		Deaths	
	Weighted % (Standard error)	Weighted % (Standard error)	Weighted % (Standard error)	Weighted % (Standard error)	AF	No AF
	AF <sup>+</sup> N=599,790	No AF N=110,926,597	AF <sup>++</sup> N=453,060	No AF N=29,294,409	AF N=21,712	No AF N=2,567,995
Mean age (years)	69.3 (0.1)	47.4 (0.2) £	70.2 (0.1)	57.1 (0.1) £	84.7 (0.07)	74.1 (0.01) £
<b>Age category</b>						
18–44 years	5.6 (0.1)	48.9 (0.3) £	4.2 (0.1)	29.7 (0.2) £	0.2	5.6 £
45–64 years	28.5 (0.3)	29.1 (0.3)	27.6 (0.2)	29.3 (0.1) £	4.3	20.4 £
65–74 years	25.7 (0.2)	9.7 (0.1) £	26.5 (0.2)	17.2 (0.1) £	9.5	18.3 £
75–84 years	24.7 (0.2)	7.5 (0.1) £	26.0 (0.2)	14.4 (0.1) £	26.6	24.1 £
85+ years	15.4 (0.2)	4.9 (0.1) £	15.8 (0.2)	9.4 (0.1) £	59.4	31.7 £
<b>Sex</b>						
Men	50.1 (0.2)	42.7 (0.2) £	50.0 (0.2)	41.0 (0.1) £	38.1	50.6 £
Women	49.9 (0.2)	57.3 (0.2) £	50.0 (0.2)	59.0 (0.1) £	61.9	49.4 £
<b>Sex and age group</b>						
Men and age <65 years	23.0 (0.3)	33.4 (0.2) £	21.4 (0.2)	22.6 (0.1) £	3.0	16.1 £
Men and age 65 years	27.2 (0.2)	9.3 (0.1) £	28.7 (0.2)	18.4 (0.1) £	35.2	34.5 £
Women and age <65 years	11.2 (0.2)	44.5 (0.3) £	10.4 (0.1)	36.4 (0.2) £	1.6	9.9 £
Women and age 65 years	38.7 (0.3)	12.7 (0.2) £	39.6 (0.2)	22.6 (0.1) £	60.3	39.5 £

Variable	Emergency Department Visits		Hospitalizations		Deaths	
	Weighted % (Standard error)		Weighted % (Standard error)		%	
	AF <sup>+</sup> N=599,790	No AF N=110,926,597	AF <sup>++</sup> N=453,060	No AF N=29,294,409	AF N=21,712	No AF N=2,567,995
<b>Health insurance</b>						
Medicare	64.0 (0.5)	27.6 (0.3) £	67.1 (0.3)	46.0 (0.2) £	NA	NA
Medicaid	6.4 (0.3)	25.0 (0.5) £	5.9 (0.1)	18.0 (0.2) £	NA	NA
Private	23.9 (0.5)	27.0 (0.5) £	22.2 (0.2)	28.2 (0.3) £	NA	NA
Other	5.6 (0.2)	20.1 (0.5) £	4.7 (0.1)	7.6 (0.1) £	NA	NA
<b>Census region (2014 population size, millions)</b>						
Northeast (44.2)	17.7 (1.1)	18.5 (1.1)	20.9 (0.5)	19.1 (0.4) £	19.7	18.1 £
Midwest (52.0)	25.3 (1.3)	23.1 (0.9) \$	24.4 (0.5)	22.6 (0.4) £	24.0	23.2 \$
South (91.7)	38.2 (1.5)	40.5 (1.3) \$	39.8 (0.7)	39.1 (0.4)	34.2	39.0 £
West (56.9)	18.8 (0.9)	17.9 (0.7)	14.9 (0.4)	19.2 (0.3) £	22.1	19.6 £
<b>Hospital location</b>						
Rural	15.4 (0.7)	15.7 (0.6)	11.3 (0.4)	9.8 (0.2) £	NA	NA
Urban non-teaching	31.3 (1.3)	30.3 (1.1)	29.1 (0.5)	27.0 (0.3) \$	NA	NA
Urban teaching	53.3 (1.4)	54.0 (1.2)	59.6 (0.6)	63.2 (0.4) £	NA	NA
<b>Comorbidities based the secondary diagnoses codes</b>						
Chronic kidney disease	11.8 (0.2)	4.1 (0.1) £	17.0 (0.2)	14.5 (0.1) £	4.8	3.3 £
Dementia	5.4 (0.1)	2.3 (0.05) £	6.9 (0.1)	6.9 (0.1)	12.2	14.8 £
Diabetes mellitus	24.2 (0.3)	12.5 (0.2) £	29.9 (0.2)	25.9 (0.1) £	9.1	9.5 \$
Heart Failure, valvular heart disease, or cardiomyopathy	34.2 (0.4)	5.4 (0.1) £	47.9 (0.2)	17.7 (0.1) £	43.6	14.4 £

Variable	Emergency Department Visits		Hospitalizations		Deaths	
	Weighted % (Standard error)		Weighted % (Standard error)		%	
	AF <sup>+</sup> N=599,790	No AF N=110,926,597	AF <sup>++</sup> N=453,060	No AF N=29,294,409	AF N=21,712	No AF N=2,567,995
Hypertension	63.5 (0.4)	25.6 (0.3)£	74.7 (0.2)	50.8 (0.2)£	17.9	15.8£
Ischemic heart disease	26.9 (0.3)	7.1 (0.1)£	35.6 (0.2)	20.7 (0.1)£	0.2	20.1£
Stroke	1.4 (0.05)	0.4 (0.01)£	2.1 (0.1)	1.7 (0.02)£	30.5	7.6£
None of above conditions	21.3 (0.4)	67.3 (0.4)£	9.5 (0.1)	37.1 (0.2)£	20.3	45.1£

£ P<0.001

§ P<0.05; AF = atrial fibrillation or flutter

† 10.3% of included AF ED visits were atrial flutter

†† 11.4% of included AF hospitalizations were atrial flutter.

Source of regional population sizes: U.S. Census Bureau, 2014 American Community Survey 1-Year Estimates

Characteristics of patients age 18 years with atrial fibrillation or flutter as the secondary diagnoses – Nationwide Emergency Department Sample 2014, National Inpatient Sample 2014 and National Vital Statistics System 2014\*

Table 2.

	Emergency Department Visits		Hospitalizations		Deaths	
	Weighted % (Standard error)		Weighted % (Standard error)		%	
Demographic	AF N=3,952,915	No AF N=106,973,681	AF N=3,523,726	No AF N=25,770,682	AF N=115,719	No AF N=2,452,276
Mean age (years)	75.6 (0.1)	46.4 (0.1)£	75.7 (0.1)	54.5 (0.1)£	82.9 (0.03)	73.6 (0.01)£
<b>Age category</b>						
18-44 years	2.1 (0.1)	50.6 (0.3)£	1.4 (0.03)	33.6 (0.2)£	0.2	5.8£
45-64 years	15.7 (0.3)	29.6 (0.2)£	15.4 (0.1)	31.2 (0.1)£	5.6	21.1£
65-74 years	21.4 (0.2)	9.2 (0.1)£	23.5 (0.1)	16.3 (0.1)£	13.0	18.5£
75-84 years	32.0 (0.2)	6.6 (0.1)£	32.8 (0.1)	11.9 (0.1)£	29.7	23.8£
85+ years	28.7 (0.3)	4.0 (0.1)£	26.9 (0.2)	7.0 (0.1)£	51.4	30.7£
<b>Sex</b>						
Men	50.1 (0.2)	42.4 (0.2)£	52.0 (0.1)	39.5 (0.1)£	46.9	50.7£
Women	49.9 (0.2)	57.6 (0.2)£	48.0 (0.1)	60.5 (0.1)£	53.1	49.3£
<b>Sex and age group</b>						
Men and age <65 years	11.3 (0.2)	34.2 (0.2)£	10.9 (0.1)	24.2 (0.1)£	4.0	16.6£
Men and age 65 years	38.8 (0.2)	8.2 (0.1)£	41.1 (0.1)	15.3 (0.1)£	42.9	34.1£
Women and age <65 years	6.6 (0.1)	45.9 (0.2)£	5.9 (0.1)	40.5 (0.2)£	1.9	10.3£
Women and age 65 years	43.3 (0.2)	11.6 (0.2)£	42.1 (0.1)	20.0 (0.1)£	51.2	39.0£
<b>Health insurance</b>						

	Emergency Department Visits		Hospitalizations		Deaths	
	Weighted % (Standard error)		Weighted % (Standard error)		%	
Demographic	AF N=3,952,915	No AF N=106,973,681	AF N=3,523,726	No AF N=25,770,682	AF N=115,719	No AF N=2,452,276
Medicare	80.9 (0.5)	25.7 (0.3) £	81.8 (0.2)	41.1 (0.2) £	NA	NA
Medicaid	5.1 (0.2)	25.8 (0.5) £	4.2 (0.1)	19.9 (0.2) £	NA	NA
Private	10.8 (0.4)	27.6 (0.5) £	11.3 (0.2)	30.5 (0.3) £	NA	NA
Other	3.1 (0.1)	20.7 (0.5) £	2.6 (0.1)	8.3 (0.1) £	NA	NA
<b>Census region (2014 population size, millions)</b>						
Northeast (44.2)	18.2 (1.2)	18.5 (1.1)	20.6 (0.5)	18.9 (0.4) £	19.0	18.1 £
Midwest (52.0)	24.5 (1.4)	23.1 (1.0)	24.5 (0.5)	22.3 (0.4) £	23.7	23.2 £
South (91.7)	38.3 (1.6)	40.6 (1.3) \$	37.3 (0.5)	39.3 (0.4) £	33.6	39.3 £
West (56.9)	18.9 (1.0)	17.9 (0.7)	17.6 (0.4)	19.5 (0.3) £	23.7	19.4 £
<b>Hospital location</b>						
Rural	13.1 (0.6)	15.8 (0.6) £	10.4 (0.3)	9.7 (0.2) £	NA	NA
Urban non-teaching	31.2 (1.4)	30.3 (1.1)	28.2 (0.4)	26.8 (0.3) £	NA	NA
Urban teaching	55.7 (1.5)	54.0 (1.1)	61.4 (0.5)	63.5 (0.4) £	NA	NA
<b>Primary diagnosis</b>						
Chronic kidney disease	0.1 (0.01)	0.1 (0.01)	0.1 (0.01)	0.1 (0.01)	1.0	1.1 \$
Dementia	0.5 (0.02)	0.2 (0.004) £	0.5 (0.01)	0.4 (0.01) £	9.3	9.6 £
Diabetes mellitus	1.0 (0.02)	1.0 (0.01)	1.1 (0.01)	1.9 (0.02) £	3.9	2.9 £
Heart Failure, valvular heart disease, or cardiomyopathy	9.4 (0.1)	0.6 (0.01) £	12.9 (0.1)	2.3 (0.02) £	9.3	5.1 £
Hypertension	1.5 (0.03)	1.0 (0.01) £	1.5 (0.03)	1.0 (0.01) £	5.9	2.7 £

Demographic	Emergency Department Visits		Hospitalizations		Deaths	
	Weighted % (Standard error)		Weighted % (Standard error)		%	
	AF	No AF	AF	No AF	AF	No AF
	N=3,952,915	N=106,973,681	N= 3,523,726	N= 25,770,682	N=115,719	N=2,452,276
Ischemic heart disease	3.4 (0.1)	0.8 (0.02) £	5.3 (0.1)	3.2 (0.04) £	21.9	13.4 £
Stroke	3.4 (0.1)	0.5 (0.01) £	4.3 (0.05)	2.1 (0.02) £	8.2	4.5 £
None of above conditions	80.7 (0.2)	95.8 (0.04) £	74.4 (0.1)	89.1 (0.1) £	42.8	61.2 £

£ P<0.001

§ P<0.05; AF = atrial fibrillation or flutter

Source of regional population sizes: U.S. Census Bureau, 2014 American Community Survey 1-Year Estimates

\* Patients with AF as the primary diagnoses were excluded from this table.



The mutually exclusive event burden of atrial fibrillation or flutter, Nationwide Emergency Department Sample 2014, National Inpatient Sample 2014 and National Vital Statistics System 2014

**Table 3.**

	Total AF, Primary Diagnosis			Total AF, Secondary Diagnosis		
	N	%	Rate/100,000 people	N	%	Rate/100,000 people
<b>Total*</b>	684,470		268.2	4,695,997		1835.4
Emergency department	224,448	32.8	88.1	1,346,436	28.7	527.9
Hospitalization	483,310	64.0	171.6	3,233,841	68.9	1262.0
Deaths	21,712	3.2	8.6	115,719	2.5	45.5
<b>Age category</b>						
18-44 years	35,698	5.2	30.9	95,349	2.0	82.6
45-64 years	191,823	28.0	229.6	756,232	16.1	905.3
65-74 years	178,709	26.1	677.0	1,067,627	22.7	4044.3
75-84 years	170,405	24.9	1245.4	1,507,461	32.1	11017.3
85+ years	107,836	15.8	1750.0	1,269,327	27.0	20598.5
<b>Sex*</b>						
Men	344,029	50.3	296.4	2,391,525	50.9	2143.6
Women	340,441	49.7	237.7	2,304,472	49.1	1581.2
<b>Sex and age group</b>						
Men and age <65 years	152,450	22.3	154.0	539,051	11.5	544.5
Men and age 65 years	191,579	28.0	941.4	1,852,474	39.4	9102.5
Women and age <65 years	75,070	11.0	75.0	312,530	6.7	312.4
Women and age 65 years	265,371	38.8	1024.9	1,991,942	42.4	7693.3

\* Rates are standardized by age to the 2010 U.S. Census Population distribution among adults aged 18 years; AF = atrial fibrillation or flutter; ED = emergency department. The crude age-sex specific rates were reported for sub group estimates.

**Table 4.** Emergency department and hospitalization outcomes, charges, and costs among patients with or without atrial fibrillation or flutter, by primary diagnosis, Nationwide Emergency Department Sample 2014 and National Inpatient Sample 2014

Primary Diagnosis	Emergency Department Visits			Hospitalizations		
	Weighted Mean or Percent (Standard Error)	P-value	Weighted Mean or Percent (Standard Error)	P-value	Weighted Mean or Percent (Standard Error)	P-value
<b>Total</b>						
	Primary AF	No AF <sup>++</sup>	Primary AF	No AF <sup>++</sup>	Primary AF	No AF <sup>++</sup>
Admitted to hospital or transferred	62.5% (0.7)	17.9% (0.2)	2.3% (0.1)	2.0% (0.02)	2.3% (0.1)	2.0% (0.02)
Died	0.04% (0.01)	0.2% (0.004)	0.9% (0.03)	2.2% (0.02)	0.9% (0.03)	2.2% (0.02)
Average length of stay (days)	NA	NA	3.5 (0.02)	4.8 (0.02)	3.5 (0.02)	4.8 (0.02)
Total charge	\$4,040 (98)	\$3,300 (77)	\$34,734 (490)	\$45,164 (547)	\$34,734 (490)	\$45,164 (547)
Total cost	NA	NA	\$8,819 (83)	\$11,711 (97)	\$8,819 (83)	\$11,711 (97)
	<b>ED Visits</b>			<b>Hospitalizations</b>		
	Comorbid AF*	No AF	Comorbid AF*	No AF	Comorbid AF*	No AF
<b>Chronic kidney disease (CKD)</b>						
Admitted to hospital or transferred	44.3 (3.6)	22.3 (3.2)	+	1.0 (0.2)	44.3 (3.6)	22.3 (3.2)
Died	+	0.22 (0.1)	+	3.5 (0.5)	+	0.22 (0.1)
Average length of stay (days)	NA	NA	5.6 (0.5)	4.0 (0.3)	NA	NA
Total charge	\$4,400(312)	\$4,335 (322)	\$48,336 (4067)	\$44,954 (4163)	\$4,400(312)	\$4,335 (322)
Total cost	NA	NA	\$12,756 (1017)	\$12,332 (1190)	NA	NA
<b>Dementia</b>						
Admitted to hospital or transferred	66.4 (1.4)	33.8 (1.0)	5.2 (0.4)	4.5 (0.2)	66.4 (1.4)	33.8 (1.0)
Died	+	+	2.5 (0.3)	1.7 (0.1)	+	+
Average length of stay (days)	NA	NA	9.3 (0.3)	10.2 (0.2)	NA	NA
Total charge	\$3,743 (147)	\$3,724 (101)	\$32,878 (924)	\$32,595 (724)	\$3,743 (147)	\$3,724 (101)
Total cost	NA	NA	\$9,564 (298)	\$9,430 (189)	NA	NA
<b>Diabetes</b>						
Admitted to hospital or transferred	69.3 (0.9)	39.2 (0.6)	2.0 (0.2)	1.3 (0.04)	69.3 (0.9)	39.2 (0.6)
Died	+	0.03 (0.002)	1.9 (0.2)	0.5 (0.02)	+	0.03 (0.002)

Primary Diagnosis	Emergency Department Visits			Hospitalizations		
	Weighted Mean or Percent (Standard Error)	P-value		Weighted Mean or Percent (Standard Error)	P-value	
	Primary AF	No AF <sup>++</sup>	No AF <sup>++</sup>	Primary AF	No AF <sup>++</sup>	No AF <sup>++</sup>
Average length of stay (days)	NA	NA	NA	6.4 (0.1)	4.6 (0.03)	<0.0001
Total charge	\$3,243 (97)	\$3,151 (83)	0.18	\$54,640 (1189)	\$37,901 (480)	<0.0001
Total cost	NA	NA		\$13,685 (221)	\$9,661 (86)	<0.0001
<b>Heart Failure, Valvular Heart Disease, or Cardiomyopathy</b>						
Admitted to hospital or transferred	88.9 (0.4)	76.5 (0.5)	<0.0001	2.7 (0.1)	3.3 (0.1)	<0.0001
Died	0.05 (0.01)	0.15 (0.01)	<0.0001	3.5 (0.1)	2.5 (0.1)	<0.0001
Average length of stay (days)	NA	NA		6.1 (0.1)	5.1 (0.04)	<0.0001
Total charge	\$2,864 (81)	\$3,413 (96)	<0.0001	\$66,158 (1486)	\$55,624 (1154)	<0.0001
Total cost	NA	NA		\$16,948 (323)	\$14,213 (232)	<0.0001
<b>Hypertension</b>						
Admitted to hospital or transferred	62.8 (1.1)	21.2 (0.5)	<0.0001	2.2 (0.2)	1.4 (0.1)	<0.0001
Died	+	0.03 (0.01)	NA	3.6 (0.2)	0.9 (0.05)	<0.0001
Average length of stay (days)	NA	NA		6.3 (0.1)	4.2 (0.04)	<0.0001
Total charge	\$3,416 (101)	\$3,360 (87)	0.40	\$56,213 (1645)	\$41,981 (860)	<0.0001
Total cost	NA	NA		\$13,991 (394)	\$10,468 (196)	<0.0001
<b>Ischemic heart disease</b>						
Admitted to hospital or transferred	90.6 (0.3)	81.7 (0.5)	<0.0001	5.7 (0.2)	7.4 (0.2)	<0.0001
Died	0.3 (0.03)	0.6 (0.03)	<0.0001	5.4 (0.1)	2.8 (0.04)	<0.0001
Average length of stay (days)	NA	NA		6.4 (0.1)	4.0 (0.02)	<0.0001
Total charge	\$4,447 (157)	\$6,882 (233)	<0.0001	\$104,357 (1609)	\$78,039 (942)	<0.0001
Total cost	NA	NA		\$25,877 (281)	\$19,282 (146)	<0.0001
<b>Stroke</b>						
Admitted to hospital or transferred	95.1 (0.3)	88.9 (0.4)	<0.0001	2.6 (0.1)	2.9 (0.1)	0.03
Died	0.4 (0.04)	0.4 (0.02)	0.77	9.9 (0.2)	5.8 (0.1)	<0.0001
Average length of stay (days)	NA	NA		5.7 (0.1)	4.9 (0.1)	<0.0001
Total charge	\$3,269 (106)	\$4,360 (113)	<0.0001	\$59,269 (1040)	\$58,712 (1141)	0.39
Total cost	NA	NA		\$14,923 (202)	\$14,554 (212)	0.01

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Not reportable based on the estimates with a relative standard error greater than 0.30. AF = atrial fibrillation or flutter

<sup>+/+</sup>These columns include all events with primary diagnosis other than AF for rows pertaining to "Total" events.

\* Results for patients with or without AF as a secondary diagnosis, "comorbid AF", exclude patients with AF as a principal diagnosis.