HHS Public Access

Author manuscript

*Am J Cardiol*. Author manuscript; available in PMC 2017 March 29.

Published in final edited form as:

*Am J Cardiol*. 2016 May 01; 117(9): 1468–1473. doi:10.1016/j.amjcard.2016.02.016.

# Racial Differences in the Prevalence and Outcomes of Atrial Fibrillation in Patients Hospitalized With Heart Failure

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## Abstract

Previous research has shown that roughly 15% to 30% of those with heart failure (HF) develop atrial fibrillation (AF). Although studies have shown variations in the incidence of AF in patients with HF, there has been no evidence of mortality differences by race. The purpose of this study was to assess AF prevalence and inhospital mortality in patients with HF among different racial groups in the United States. Using the National Inpatient Sample registry, the largest publicly available all-payer inpatient care database representing >95% of the US inpatient population, we analyzed subjects hospitalized with a primary diagnosis of HF from 2001 to 2011 (n = 11,485,673) using the *International Classification of Diseases, Ninth Edition* (*ICD 9*) codes 428.0-0.1, 428.20-0.23, 428.30-0.33, 428.40-0.43, and 428.9; patients with AF were identified using the *ICD* 9 code 427.31. We assessed prevalence and mortality among racial groups. Using logistic regression, we examined odds of mortality adjusted for demographics and co-morbidity using Elixhauser co-morbidity index. We also examined utilization of procedures by race. Of the 11,485,673 patients hospitalized with HF in our study, 3,939,129 (34%) had AF. Patients with HF and AF had greater inhospital mortality compared with those without AF (4.6% vs 3.3% respectively, p <0.0001). Additionally, black, Hispanic, Asian, and white patients with HF and AF had a 24%, 17%, 13%, and 6% higher mortality, respectively, than if they did not have AF. Among patients with HF and AF, minority racial groups had underutilization of catheter ablation and cardioversion compared with white patients. In conclusion, minority patients with HF and AF had a disproportionately higher risk of inpatient death compared with white patients with HF. We also found a significant underutilization of cardioversion and catheter ablation in minority racial groups compared with white patients.

Current understanding of the epidemiology of atrial fibrillation (AF) in patients with heart failure (HF) is based primarily on white and black patients with limited data on other racial groups. Currently, 54 million Hispanics live in the United States with 129 million expected by 2060, making up 31% of the entire population.[1] Additionally, Asians had the highest growth rate, 46%, of any racial group from 2000 to 2010.[2] Although the number of subjects

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**Disclosures**

The authors have no conflicts of interest to disclose.

>65 years is expected to increase over the next several decades, the growth rate in whites is slower compared with blacks, Hispanics, and Asians, highlighting the need for further study in these populations.[3] No previous studies have assessed mortality difference in patients with HF suffering from AF across different racial groups. The goal of this study was to determine racial differences in the prevalence of AF in patients with HF and to evaluate procedure utilization and inhospital mortality in this subgroup of patients who have both AF and HF. Finally, with use of over a decade of National Inpatient Sample (NIS) data, we also examined whether any of these relations had significant temporal trends.

## Methods

This study involved a population-based sample of patients with HF who were admitted to hospitals in 44 states from 2001 to 2011. The 2001 to 2011 NIS is a set of hospital inpatient databases collected by the Healthcare Cost and Utilization Project. The NIS is the largest publicly available all-payer inpatient care database, with discharge data from 1,045 hospitals, a stratified sample of 20% of all US hospital discharges. These data include primary and second admission diagnoses; primary and secondary procedures; admission and discharge status; demographic information such as sex, age, race and ethnicity, zip-code derived median income, and length of stay; and hospital region, teaching status, ownership type, and bed size.

Diagnoses and procedures were identified from the *International Classification of Diseases, Ninth Edition, Clinical Modification* (*ICD-9 CM*) diagnostic codes. Our sample included subjects who were admitted with a principal diagnosis of systolic, diastolic, or systolic and diastolic HF. We identified these patients using *ICD-9* codes that encompassed acute and chronic, systolic and diastolic HF, and HF not otherwise specified (428.0-0.1, 428.20-0.23, 428.30-0.33, 428.40-0.43, 428.9). AF was defined using *ICD-9* code 427.31.

Our purpose was to determine racial differences in the prevalence of AF in patients with HF and to evaluate inhospital mortality. The study population with a principle diagnosis of HF was divided into 2 groups: (1) HF cases with AF and (2) HF cases without AF. Within this population, we identified 11,485,673 admissions for HF for a period of 11 years. We also examined procedure utilization with the following procedures: (1) cardioversion (99.61, 99.62, 99.69) and (2) catheter ablation (37.34). Finally, we examined these relations by year of admission to assess any trends over time.

Baseline co-morbidities were identified using methods described by Elixhauser et al.[4] The Elixhauser method has been shown to be the co-morbidity measurement method of choice for administrative data. Furthermore, these methods were validated within a subset of the NIS, were determined to be predictive of mortality within this database, and are recommended for adjustment for severity in the NIS database by the Agency for Healthcare Quality Research.[5]

We used SAS software, version 9.1, for all analyses (SAS Institute Inc., Cary, North Carolina). Univariate and distributional analyses included measures of central tendency, kurtosis, and skew. Bivariate comparisons, such as those comparing the patient

characteristics and inhospital mortality, were made using Pearson chi-square tests for dichotomous outcomes and with *t* tests or 1-way analysis of variance for continuous outcomes. Multivariable logistic regression models were used to assess the association of HF and AF with each outcome (prevalence and inhospital mortality) with covariates including age, gender, income, Elixhauser co-morbidities, and hospital length of stay.

Co-morbidities included in the regression models were hypertension, coronary artery disease, chronic lung disease, diabetes mellitus, cardiomyopathy, obesity, myocardial infarction, hyperthyroidism, and hypothyroidism. All analyses were weighted using NIS-provided weights to create national estimates for all analyses.

## Results

Of the 11,485,673 patients hospitalized with HF in our study, 3,939,129 (34%) had AF (Table 1). Patients with HF and AF had greater inhospital mortality compared with those with HF without AF (4.6% vs 3.3%, respectively, $p < 0.0001$). Although gender distribution between the 2 groups were similar, patients with HF and AF tended to be significantly older than those with HF without AF. The difference in age was more significant in women compared with men (Table 1).

Table 1 illustrates the difference in the co-morbidity rates between patients with HF with and without AF and the racial breakdown of co-morbidities. In regard to prevalence of AF in HF, whites constituted the greatest portion of patients with HF and AF compared with other racial groups (Table 1). After adjustment for demographics and co-morbidities, we found blacks, Hispanics, Asians, and “other race” patients with HF were 47%, 36%, 19%, and 28% less likely, respectively, to have AF than white patients with HF (Table 2).

Table 3 lists, after adjustment for demographics and co-morbidities, patients with HF and AF had a 13% higher inhospital mortality than if they did not have AF. Furthermore, there was a significant difference in mortality among racial groups. Black patients with HF and AF had a 24% higher mortality than if they did not have AF, whereas Hispanic, Asian, and white patients with HF had a 17%, 13%, and 6% higher mortality than if they did not have AF, respectively.

Table 4 demonstrates the inhospital use of cardioversion in patients with HF suffering from AF. It can be seen that, compared with white patients with HF, there was an underutilization of these 2 procedures among minority racial groups. Specifically, black patients with HF and AF were 38% less likely to undergo cardioversion compared with white patients with HF and AF. Similarly, Hispanic and Asian patients with HF and AF were 39% and 33% less likely to undergo cardioversion, respectively. Table 5 illustrates the inhospital use of catheter ablation in patients with HF and AF. black, Hispanic, and Asian patients with HF and AF were 17%, 22%, and 62% less likely, respectively, to undergo catheter ablation compared with white patients with HF and AF.

Table 6 illustrates the decreasing percent inhospital mortality and crude mortality of patients with HF and AF from 2001 to 2011 stratified by racial group.

## Discussion

Using the NIS from 2001 to 2011, the largest all-payer inpatient database in the United States that is representative of >95% of the population, we have demonstrated racial differences in the prevalence and inhospital mortality rates among white, black, Hispanic, and Asian patients with HF with concomitant AF. Previous studies assessing racial differences in the prevalence and inhospital mortality of patients with HF and AF have only assessed those of white or black race. Furthermore, we believe our study has several clinical implications.

First, patients with HF and AF suffered significantly greater mortality than those without AF, with blacks experiencing the greatest disproportionate effect on mortality associated with AF as a co-morbidity. Additionally, although white patients with HF had a significantly greater prevalence of AF compared with all other racial groups, black patients with HF accounted for the highest mortality rate in AF patients with HF. Last, we noted a significant underutilization of catheter ablation and cardioversion among minority racial groups with HF and AF compared with white patients with HF and AF.

Previous studies have found a lower rate of AF in black patients compared with white patients.[6–12] Rodriguez et al, conducting the first major study to characterize the incidence of AF across several racial groups, found that the incidence of hospitalized AF in 6,712 Multi-Ethnic Study of Atherosclerosis patients was significantly lower in Hispanics, blacks, and Chinese than in whites.[13] However, few studies have analyzed racial differences in prevalence and inhospital mortality in patients with HF and AF. Thomas et al[14] analyzed 135,494 hospitalizations from 2006 to 2012 at 276 hospitals participating in the American Heart Associations Get with the Guidelines HF program. Their results indicated that although black patients with HF were 48% less likely to have AF, there were no racial differences in inhospital mortality. Other research has shown that black patients with HF have a lower prevalence of AF compared with whites,[7,14] which is consistent with the findings of this study. However, no study to date has assessed racial differences in prevalence and inhospital mortality among all racial groups suffering from AF with HF.

In this study, we found AF is prevalent in 34% of patients with HF, a finding that is slightly lower than that found in previous studies.[7,14,15] Additionally, as can be seen in Table 2, white patients with HF were most likely to have AF compared with other patients with HF from other racial groups. However, as can be seen in Table 1, white patients with HF compared with those from other racial groups had the lowest rates of diabetes mellitus, hypertension, cardiomyopathy, hyperthyroidism, and the second lowest rate of obesity, all of which are traditional AF risk factors. It has been established previously that traditional risk factors may not fully explain true incidence rates, given AF risk factors have been derived from populations not reflective of the heterogeneous racial groups of the United States.[16] Thus, further studies are necessary to determine what factors are responsible for the difference in incidence of AF among racial groups.

Contrary to previous studies, we found that there are racial differences in mortality in patients with HF and AF. Specifically, black patients with HF and AF were 24% more likely

to suffer an inhospital death than if they did not have AF (Table 3). Given the lack of previous data, there has not been a focus on reducing racial disparities in national guidelines such as the American College of Cardiology/ American Heart Association guidelines on patients with HF and AF[17]; however, using the results from this study, future studies will need to determine the etiology of disproportionately increased mortality and the possible incorporation of race in future risk models and guidelines.

Our study included systolic HF, diastolic HF, or patients suffering from both systolic and diastolic HF. In this study, blacks had the highest rates of hypertension, obesity, and cardiomyopathy, 3 known risk factors for the development of AF.[16] However, even after adjustment for all major AF risk factors, black patients with HF still had the greatest increase in mortality if they had AF than if they did not compared with other racial groups, suggesting there are factors other than the traditional AF risk factors that lead to an increase in inhospital mortality in the setting of HF with AF.

There are several possibilities as to why there was a difference in prevalence and inhospital mortality between racial groups suffering from HF with AF. Genetic variability has become an increasingly recognized hypothesis to explain racial differences observed in patients with AF and HF.[18,19] Compared with patients with HF of European ancestry, African patients with HF have been associated with allele frequency-based genetic profiles that possibly alter the natural history of HF and attenuate certain medical therapies.[20] Previous studies have also found racial differences in left atrial size and atrial automaticity, which may contribute to a pro-arrhythmic state.[21,22]

Racial and ethnic disparities in health care in the United States have been studied extensively, with minorities receiving poorer quality of care for several clinical conditions in the inpatient setting,[23,24] including cardiovascular procedures.[25–27] Over the last decade, AF ablation has been used more commonly and recent data continue to show a higher chance of maintaining sinus rhythm with ablation versus medical therapy alone. In our study, we found a significant underutilization of cardioversion and catheter ablation among minority racial groups suffering from HF and AF compared with white patients with HF and AF (Tables 4 and 5). Although no study to date has shown a survival benefit in patients with HF and AF who received either procedure, recent studies have noted catheter ablation may improve left ventricular ejection fraction, quality of life, functional capacity, and neurohormonal profile.[28,29] Future studies including the RAFT AF (A Randomized Ablation-Based Atrial Fibrillation Rhythm Control vs Rate Control Trial in Patients with Heart Failure and High Burden Atrial Fibrillation) and CASTLE-AF (Catheter Ablation vs Standard Conventional Treatment in Patients With Left Ventricular Dysfunction and Atrial Fibrillation) may provide further insight into this therapy. Other reasons for the difference in inhospital mortality among various racial groups remain unclear, and our findings from this study should fuel further trials to decipher and stratify other attributes that may lead to a difference in survival.

Our study has several strengths. This was a large, contemporary group of patients hospitalized with HF that is representative of the changing ethnic demographics of the United States. Using the NIS from 2001 to 2011, we were not only able to obtain unbiased results but also assess temporal trends in prevalence and inhospital mortality among all

racial groups, factors that have not previously been assessed in the available medical literature.

The limitations of our study are mostly related to use of an administrative database, which can include coding errors. Although coding errors are possible, we believe they are not likely to differ between patient groups. Although the number of hospital admissions we report may be greater than the true number of HF admissions, this is unlikely to impact any of the trends we noted in patients with HF because of the large sample size of this study. Furthermore, the NIS allowed us to evaluate patient characteristics, such as age and gender, but we were unable to examine any differences in medication use; however, this was not the main study question. Future studies can look at differences in medications and procedures that are used for treating AF patients from the various races examined in our study.

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## Table 1

Clinical and demographic characteristics of heart failure study participants

| | With AF | Without AF | p Value |
|---|---|---|---|
| Overall HF cases | 11,485,673 | | |
| Overall cases | 3,939,129 (34%) | 7,546,545 (66%) | 0.002 |
| Females | 2,045,259 (52%) | 3,925,510 (52%) | |
| Males | 1,893,870 (48%) | 3,621,035 (48%) | |
| Mean age (years) | | | <0.0001 |
| Overall | 78 ± 11 | 71 ± 15 | |
| Females | 80 ± 23 | 68 ± 15 | |
| Males | 75 ± 26 | 73 ± 15 | |
| Race | | | <0.0001 |
| White | 2,515,882 (64%) | 3,771,497 (50%) | |
| Black | 297,685 (7.6%) | 1,288,977 (17%) | |
| Hispanic | 172,059 (4.4%) | 532,221 (7.1%) | |
| Asian | 47,152 (1.2%) | 98,089 (1.3%) | |
| Others | 65,752 (1.7%) | 164,596 (2.2%) | |
| Missing | 840,599 (21%) | 1,691,165 (22%) | |
| Median household income | | | <0.0001 |
| $1–39,999 | 870,413 (22%) | 2,144,402 (28%) | |
| $40,000–49,999 | 855,500 (22%) | 1,595,131 (21%) | |
| $50,000–65,000 | 793,302 (20%) | 1,268,030 (17%) | |
| $66,000+ | 707,260 (18%) | 950,637 (13%) | |
| In-hospital mortality | 180,254 (4.6%) | 248,879 (3.3%) | <0.0001 |
| Comorbidities | | | <0.0001 |
| Hypertension | 2,376,007 (60%) | 4,927,263 (65%) | |
| Coronary artery disease | 1,721,806 (44%) | 3,391,406 (45%) | |
| Chronic lung disease | 1,419,316 (36%) | 2,638,479 (35%) | |
| Diabetes mellitus | 1,343,648 (34%) | 3,363,692 (45%) | |
| Cardiomyopathy | 768,592 (20%) | 1,615,558 (21%) | |
| Hypothyroidism | 599,680 (15%) | 876,255 (12%) | |
| Obesity | 309,123 (7.9% | 825,763 (11%) | |
| Myocardial Infarction | 107,906 (2.7%) | 276,078 (3.7%) | |
| Hyperthyroidism | 22,883 (0.6%) | 23,913 (0.3%) | |
| Comorbidities by race | | | |
| Hypertension | | | <0.0001 |
| White | 1,502,933 (60%) | 2,319,670 (62%) | |
| Black | 216,227 (73%) | 1,002,663 (78%) | |
| Hispanic | 115,618 (67%) | 386,429 (73%) | |
| Asian | 31,325 (66%) | 71,066 (72%) | |
| Other | 41,711 (63%) | 112,315 (68%) | |
| Coronary artery disease | | | <0.0001 |

| | With AF | Without AF | p Value |
|---|---|---|---|
| White | 1,156,016 (46%) | 1,874,111 (50%) | |
| Black | 105,164 (35%) | 428,870 (33%) | |
| Hispanic | 77,380 (45%) | 246,155 (46%) | |
| Asian | 19,682 (42%) | 45,128 (46%) | |
| Other | 28,593 (43%) | 77,732 (47%) | |
| Chronic lung disease | | | <0.0001 |
| White | 930,010 (37%) | 1,399,678 (37%) | |
| Black | 101,972 (34%) | 414,760 (32%) | |
| Hispanic | 57,132 (33%) | 152,922 (29%) | |
| Asian | 13,656 (29%) | 25,252 (26%) | |
| Other | 22,115 (34%) | 51,354 (31%) | |
| Diabetes mellitus | | | <0.0001 |
| White | 831,657 (33%) | 1,578,567 (42%) | |
| Black | 119,405 (40%) | 609,979 (47%) | |
| Hispanic | 76,698 (45%) | 313,658 (59%) | |
| Asian | 19,121 (41%) | 50,969 (52%) | |
| Other | 25,869 (39%) | 83,531 (51%) | |
| Cardiomyopathy | | | <0.0001 |
| White | 445,875 (18%) | 678,459 (18%) | |
| Black | 101,171 (34%) | 419,317 (33%) | |
| Hispanic | 44,147 (26%) | 125,004 (23%) | |
| Asian | 10,875 (23%) | 23,095 (24%) | |
| Other | 13,487 (21%) | 35,266 (21%) | |
| Hypothyroidism | | | <0.0001 |
| White | 423,205 (17%) | 535,939 (14%) | |
| Black | 25,468 (8.6%) | 77,193 (6.0%) | |
| Hispanic | 22,259 (13%) | 53,745 (10%) | |
| Asian | 4,757 (10%) | 8,209 (8.4%) | |
| Other | 9,605 (15%) | 17,530 (11%) | |
| Obesity | | | <0.0001 |
| White | 192,751 (7.7%) | 379,881 (10%) | |
| Black | 39,865 (13%) | 202,026 (16%) | |
| Hispanic | 16,536 (9.6%) | 61,988 (12%) | |
| Asian | 2,389 (5.1%) | 5,958 (6.1%) | |
| Other | 5,806 (8.8%) | 18,012 (11%) | |
| Myocardial infarction | | | <0.0001 |
| White | 72,222 (2.9%) | 161,994 (4.3%) | |
| Black | 5,776 (1.9%) | 25,956 (2.0%) | |
| Hispanic | 4,051 (2.4%) | 17,718 (3.3%) | |
| Asian | 1,658 (3.5%) | 5,110 (5.2%) | |
| Other | 1,814 (2.8%) | 6,643 (4.0%) | |
| Hyperthyroidism | | | <0.0001 |

| | With AF | Without AF | p Value |
|---|---|---|---|
| White | 13,305 (0.5%) | 10,186 (0.3%) | |
| Black | 2,676 (0.9%) | 5,785 (0.5%) | |
| Hispanic | 1,153 (0.7%) | 1,577 (0.3%) | |
| Asian | 551 (1.2%) | 485 (0.5%) | |
| Other | 586 (0.9%) | 682 (0.4%) | |

AF = atrial fibrillation; HF = heart failure.

**Table 2**

Racial differences in AF prevalence in HF study participants

| Race | Odds Ratio (95% CI) | p Value |
|---|---|---|
| White | *Reference* | |
| Black | 0.53 (.53–.54) | <.0001 |
| Hispanic | 0.64 (.64–.65) | <.0001 |
| Asian | 0.81 (.80–.82) | <.0001 |
| Others | 0.72 (.72–.73) | <.0001 |

**Table 3**

In-hospital mortality of HF study participants with AF versus without AF

| Overall Odds Ratios: | Odds Ratio (95% CI) | p Value |
|---|---|---|
| Overall | 1.13 (1.12–1.13) | <.0001 |
| White | 1.06 (1.06–1.07) | <.0001 |
| Black | 1.24 (1.21–1.27) | <.0001 |
| Hispanic | 1.17 (1.14–1.21) | <.0001 |
| Asian | 1.13 (1.06–1.19) | <.0001 |
| Others | 1.16 (1.11–1.22) | <.0001 |

**Table 4**

In-hospital use of cardioversion in AF with HF study participants

| Race | Odds Ratio (95% CI) | p Value |
|---|---|---|
| White | *Reference* | |
| Black | 0.62 (0.61–0.64) | <.0001 |
| Hispanic | 0.61 (0.59–0.64) | <.0001 |
| Asian | 0.67 (0.63–0.72) | <.0001 |
| Others | 0.81 (0.77–0.85) | <.0001 |

**Table 5**

In-hospital use of catheter ablation in AF with HF study participants

| Race | Odds Ratio (95% CI) | p Value |
|---|---|---|
| White | *Reference* | |
| Black | 0.83 (0.79–0.88) | <.0001 |
| Hispanic | 0.78 (0.73–0.84) | <.0001 |
| Asian | 0.38 (0.31–0.45) | <.0001 |
| Others | 1.19 (1.08–1.31) | 0.0004 |

**Table 6**

Percent in-hospital mortality among HF study participants with AF

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| White | 6.2% (12,639) | 5.9% (11,659) | 5.7% (12,027) | 5.5% (12,037) | 5.3% (12,202) | 4.9% (11,155) | 4.4% (9,416) | 3.9% (9,025) | 4.2% (10,830) | 4.0% (9,940) | 3.9% (10,652) |
| Black | 4.3% (818) | 4.6% (927) | 3.7% (880) | 4.2% (1,081) | 3.7% (766) | 3.9% (1,067) | 3.1% (862) | 2.5% (655) | 2.4% (743) | 2.5% (932) | 2.5% (1,001) |
| Hispanic | 5.3% (593) | 4.7% (584) | 5.2% (892) | 4.8% (706) | 4.0% (602) | 4.4% (783) | 3.0% (445) | 3.1% (478) | 2.9% (509) | 3.3% (551) | 3.4% (684) |
| Asian | 6.0% (188) | 6.0% (195) | 5.2% (213) | 6.8% (279) | 5.2% (174) | 4.7% (200) | 3.7% (164) | 3.7% (177) | 3.1% (170) | 3.2% (174) | 4.8% (235) |
| Others | 6.5% (228) | 6.1% (260) | 5.1% (213) | 6.3% (298) | 5.3% (258) | 5.9% (326) | 4.3% (281) | 4.1% (340) | 4.0% (374) | 3.4% (241) | 3.2% (235) |
| p value | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 |