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Eleven-year trends of inpatient pacemaker implantation in patients diagnosed with sick sinus syndrome

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Abstract

Background—Pacemakers (PM) are used for managing sick sinus syndrome (SSS). This study evaluates predictors and trends of PM implantation for SSS.

Methods—Patients were identified from the National Inpatient Sample dataset (2003–2013). Included patients were 18 years old, had a diagnosis of sinus node dysfunction and atrial arrhythmia (i.e., SSS). Patients who died, transferred out, who had prior device, or had a defibrillator or resynchronization therapy device implanted were excluded. Included patients were then stratified by if a PM was implanted. Data regarding SSS, trends of PM utilization, and multivariable models of factors associated with PM implantation are presented.

Results—Note that 328,670 patients satisfied study criteria. This study compared patients who underwent (87.4%) PM implantation to those who did not undergo (12.6%) PM implantation. The annual trends for hospitalization with SSS and PM placement have been decreasing ($P < 0.001$). Variables associated with lower likelihood for PM implantation include young age, female sex, non-Caucasian race, chronic heart failure, Charlson Comorbidity Score 1, emergency room and week-end admission, hospital stay 3 days, and high cardiology inpatient volume. Greater likelihood for PM implantation was associated with hyperlipidemia, hypertension, and hospitals that were either private, large, Northeastern location, or with high cardiac procedural volume.

Conclusions—Analyzing 11-year data from a national inpatient database demonstrate a number of relevant variables that impact PM utilization that include not only clinical but also nonclinical variables such as socioeconomic status, gender, and hospital features. Racial and gender bias toward PM implantation are unchanged and persist through 2013.

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Keywords

atrial fibrillation; hospitalization; pacemakers; sick sinus syndrome

1 INTRODUCTION

Sick sinus syndrome (SSS) is a constellation of findings characterized by abnormal sinoatrial nodal function, resulting in symptomatic bradyarrhythmias, and often associated with recurrent tachyarrhythmias (atrial fibrillation).¹ Annual incidence of SSS in individuals 45 years and older is close to one per 1,000² and approximately 49% are women and 17% are non-Caucasian.^{3,4} Pacemaker (PM) implantation has increased between 1993 and 2009⁵ and is commonly used for treatment of SSS. However, racial,^{6,7} gender,^{8,9} and hospital⁹ disparities have been reported to present barriers to PM implantation. The purpose of this study, therefore, is to query, over an 11-year period (2003–2013), a United States national inpatient database to analyze features that impact PM implantation and to evaluate if previously reported bias trends continue.

2 METHODS**2.1 Data source**

Deidentified data of adult SSS patients from the 2003 to 2013 US National Inpatient Survey (NIS) database was collated. Inclusion criteria were patients 18 years of age and who were diagnosed with SSS, defined as having a primary diagnostic ICD-9 code of sinoatrial node dysfunction (427.81) complicated with any code of atrial fibrillation (427.31) or atrial flutter (427.32). Patients with codes of previous PM implantation procedure (V450) who died during hospitalization, transferred to short-term hospital, skilled nursing facility or intermediate care facility or who left hospital against medical advice were excluded from analysis. Patients who underwent implantation of a cardioverter- defibrillator or a cardiac resynchronization therapy device were also excluded.

Patients who satisfied these inclusion and exclusion criteria (i.e., diagnosis of SSS) were then stratified by PM implantation and a comparison between those who did versus those who did not receive a PM was performed to assess variables that may impact utilization of device therapy. This protocol was approved by the Ohio State University Institutional Review Board.

2.2 PM definition

Cardiac implantable electronic devices included only single and dual chamber PM. Patients who received PM during hospitalization were determined by corresponding ICD-9 procedure codes of device implantation (37.80, 37.81, 37.82, 37.83).

2.3 Patient variables

Patient variables that were collated, using ICD-9 diagnostic codes, included: age, gender, race, smoking status, insurance type, admission type, admission time, length of stay, household income, hyperlipidemia, hypertension, coronary artery disease (CAD), chronic

heart failure (CHF), chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), and comorbidities and comorbidity score. To represent the overall health status, comorbidity score was calculated using the updated version of Charlson index. Household income was defined as the median household income of the community in which the patient resided.

2.4 Hospital variables

Several hospital characteristics that may have an impact on accessibility of PM implantation were included in analysis. Hospitals were classified as public or private, and as rural, urban nonteaching, or urban teaching. The region of hospital location within the US was classified as Northeast, Midwest, West, or South. Hospital size was classified as small, medium or large according to the number of beds. In addition, cardiac procedure volume and cardiology inpatient volume were collated. Cardiac procedure volume was estimated from the number of visits that have at least one cardiac procedure code and was adjusted by the trend weight. The cardiology inpatient volume was estimated from the total number of visits with cardiovascular disease as the primary diagnosis and adjusted by the trend weight. Also, cost per hospitalization was collected.

2.5 Statistical methods

All descriptive measures reported in this article were estimated using sampling weight. The temporal distribution of PM implantation rates is presented per year. Total number of SSS admissions and PM implantation procedures were obtained from trend weight. The trend weight accounts for both the multistage stratified sampling and the comparability across different years. The temporal trend of annual PM implantation rate in SSS patients were described using line plots and stratified by device types. Further line plot was drawn for average hospital cost for device implantation. The trends of categorical variables were tested using the Cochran Armitage test, while the trends of continuous variables were tested by t tests for the linear slopes. Demographics were presented with categorical variables analyzed using weighted chi-square tests, while means were compared using t -tests appropriate for multistage sampling.

In multivariable analyses, continuous variables were categorized. Odds ratios (ORs) and 95% confident intervals (CIs) of all explanatory variables using multiple logistic regression models are provided. Discharge weight was used in the model to account for the multistage sampling effect. Patient and hospital variables were included in the final model and the ORs, CIs, and P values are presented. The P value for this analysis was set at 0.05.

Interaction terms (male vs. female sex, white vs. non-white race, private vs. public insurance type, teaching vs. nonteaching hospital) were added to multivariable models to compare the OR of risk factors. The level of significance for P statistics was set to be 0.05. All analyses were conducted in SAS 9.4 software (SAS Institute Inc., Cary, NC, USA).

3 RESULTS

3.1 Study population

During the year 2003–2013, there were 433,845 inpatient admissions for SSS, accounting for 0.1% of 424 million hospitalizations in the United States. After accounting for the exclusion factors, 328,670 patients were diagnosed with SSS in whom PM was implanted in 87.4% ($n = 287,412$). These patients who did receive a PM were then compared to 41,258 SSS patients who did not undergo device implantation (Table 1). The mean age for the study population was 77.5 years, 54.2% were female, 71.3% were white, 87% were Medicare/Medicaid insured and there was similar (~23–26% each) distribution among all income groups.

3.2 Temporal patterns

The number of SSS inpatient visits increased from 31,815 in 2003 to 32,964 in 2009, but sharply decreased to 22,410 in 2013 ($\chi^2_{trend} = 50.0449$, $P < 0.001$). In a similar manner, Figure 1 reflects a significant reduction in PM implantation beginning in 2010, primarily due to a drop in dual chamber PM devices.

Over the 11-year period of time, there was a statistically significant increase in the trend in the mean age of patients undergoing PM implantation (about 77.3 years) albeit the absolute change is small ($\beta_{slope} = 0.042$, $P < 0.001$). There has been an increase in proportion of patients with Medicare since 2008 ($\chi^2_{trend} = -10.9$, $P < 0.001$) for all devices. The overall per hospitalization charge trends for all devices has increased over the years ($\beta_{slope} = 2655$, $P < 0.001$; Fig. 2).

3.3 Univariate analysis SSS patients: With versus those without PM

The distribution of all collated variables was statistically different among patients with compared to those without PM implantation, except for smoking history and hypertension. (Table 1).

3.4 Multivariate analysis of patient variables associated with PM implantation (Table 2)

Male sex, white race, age 66–85 and comorbidities of hyperlipidemia were positively associated with likelihood of PM implantation (OR 1.15, 1.21, 1.38, 1.18, respectively, $P < 0.001$ for each variable). However, age less than 40, ages 41–65, CKD, CHF and Charlson index -1 were negatively associated with implantation rate (OR = 0.46, 0.94, 0.80, 0.93, and 0.85, respectively, $P < 0.05$). Also, emergency admissions, weekend admissions and admissions of less than 4 days of stay were less likely to receive device implantation (OR = 0.31, 0.76 and 0.51, respectively, $P < 0.001$). Household income, COPD, and CAD did not impact implantation rates.

3.5 Multivariate analysis of hospital variables associated with PM implantation (Table 3)

Table 3 presents hospital characteristics and their effects in the multivariable model. Public and small hospitals have a lower likelihood of implantation (OR = 0.89 and 0.79, respectively, $P < 0.001$). Also, a decreased chance of implantation was noted among hospitals

in regions Midwest, South, and West when compared to hospitals in the Northeast United States ($P < 0.001$). Hospitals with higher cardiology inpatient volume were associated with a lower likelihood of PM implantation ($P < 0.001$), whereas higher cardiac procedure volume was associated with higher likelihood of implantation ($P < 0.001$).

3.6 Multivariate analysis stratified by gender, race, insurance, and teaching hospital

Tables 4–7 present ORs for PM implantation by multivariate analysis stratified by four predefined variables: gender, race, insurance, and teaching hospital. Many of the findings were contrary to the findings in the nonstratified multivariate analysis.

3.6.1 Gender—Female patients were more likely to have PM implantation at a younger age. In addition, white patients were more likely to have an implantation and this finding was even more significant in white males than in white females. Females are less likely to be implanted with a Medicare/Medicaid status, whereas male patients with Medicare/Medicaid are more likely to undergo implantation. Public hospital was associated with lower odds of PM implantation in female patients but not in male patients.

3.6.2 Race—Non-white younger patients (age 41–65) were more likely to have implantation compared to non-white older patients, whereas such association was reversed in white patients. Hospital teaching status and household income impacted PM implantation only in non-white patients. Besides, the negative association between Charlson comorbidity score and implantation was higher in magnitude in non-white patients.

3.6.3 Insurance—Insurance type may modify the effect of patient level characteristics. Young patients were less likely to obtain a device in both insurance types. However, young Medicare or Medicaid beneficiaries were much less likely to undergo implantation than young patients covered by private or other insurance plans (OR: 0.23 vs. 0.85). The statistical likelihood of PM implantation is higher in Medicare/Medicaid male (OR: 1.2) and white (OR: 1.22) patients. Furthermore, patients with higher comorbidity score and patients in lower household income quartile who were covered by private or other insurance plans were more likely to undergo PM implantation, while such patients covered by Medicare or Medicaid were less likely to be implanted. Nonetheless, the ownership, teaching status, and size of hospitals did not change accessibility of delivering implantation service.

3.6.4 Teaching hospital—White patients have higher likelihood of getting a device, especially in a teaching hospital. Medicare or Medicaid beneficiaries in teaching hospital were more likely to obtain an implantation, whereas such group of patients were less likely to be implanted in nonteaching hospitals. However, the comorbidity score and household income of patients has no heterogeneous effect among patients hospitalized in teaching and nonteaching hospitals.

4 DISCUSSION

The current study was designed to identify the relevant factors associated with PM implantation in patients hospitalized with SSS. The major findings of this analysis using an inpatient database are that (1) PM implantation rates increased from 2003 to 2009 before

sharply decreasing through 2013; (2) despite the overall decrease in PM implantations, the proportion of dual-chamber PM implantation has increased; (3) female sex, non-Caucasian race, short admissions, elective admission, weekend admission, and high Charlson comorbidity index are patient level factors associated with decreased likelihood for PM implantation; (4) public hospitals¹⁰ small hospitals, hospitals other than those located in the Northeast⁹ and hospitals with high cardiology inpatient volume are less likely to perform PM implantation; (5) hospitals with high cardiac procedure volume are positively associated with PM implantation; and (6) teaching hospitals have a higher likelihood of device implantation at a younger age and with Medicare/Medicaid insurance. Similarly, other stratified multivariate analyses further support the conclusions of the multivariate analysis in that female sex, non-Caucasians, and Medicare/Medicaid patients are less likely to be treated with a PM for SSS. Despite prior publications reporting racial^{6,7} and gender^{8,9} bias to PM implantation, the findings of the current study suggest that these biases are unchanged and persist through 2013.

Multiple studies have reported that non-Caucasian populations have lower rates of receiving PM.^{6,7,9,11–14} Similarly, gender disparity has reported lower PM implantation in women.^{7,8,11,14–17} The current study demonstrates similar racial and sexual disparity in the SSS population with reduced utilization in non-Caucasians and females. The explanation for this finding is likely multifactorial. Multivariate analysis suggests that lower household income is associated with reduced PM implantation among non-whites^{14,18} yet, patients with Medicare/Medicaid insurance were not underserved. Also, even though women and non-Caucasian race are less likely to have PM implant compared to men and white race, respectively, it was noticed that younger patients in this underserved population were more likely to get implanted than the older patients. We are unable to find a reason for this practice except that this might indicate less comorbidities in younger patients, which makes them better candidates for PM implantation.

Previous studies using the NIS database demonstrated that permanent PM implantation increased between 1993 and 2001 before either slightly declining¹⁹ or plateauing⁵ through 2006 to 2009. The current study adds to these findings by evaluating patients admitted to the hospital for SSS and extending the time period to 2013. Implantation rates were stable from 2003 to 2009, but surprisingly noted that after 2009, PM implantation rates precipitously dropped through 2013. As the NIS database only contains data on hospitalized patients, it is possible that the reduction in PM implantation after 2009 may represent a shift from inpatient to the ambulatory setting. The decline may also represent a shift in management at the provider level in avoiding PM implantation as a result of the U.S. Department of Justice civil investigation.²⁰ Finally, the emergence of wearable heart rate monitoring devices in 2008 may have increased awareness of heart rate.²¹

Although it is obvious why high procedure volume was associated with higher device implantation, it is more challenging to reconcile the lower likelihood of PM utilization with high inpatient volumes. We can hypothesize that this is related to movement towards a value based system in which hospitals with high inpatient volumes unload procedures for lower cost to outpatient setting in turn reducing hospitalization cost and overall costs.²²

We found negative association of emergency and weekend admission with device implantation. We think these data are supported by negative health and economic outcomes^{23–25} with emergency and weekend stays shown before. This data supports the hypothesis of value-based care²² given outpatient treatment in times when it is clinically appropriate, is cost efficient, and is associated with better outcomes overall.

Consistent with prior cardiac studies,²⁶ stratified analysis shows Medicare/Medicaid insurance status leads to PM implantation at an older age with no effect of hospital ownership or comorbidity score (contrary to nonstratified analysis). Also, this is the first report that compared public and private insurance that found patients' age, sex, and socioeconomic status give directional relationship to PM utilization when patient had private or public insurances.

Stratified analysis of teaching versus nonteaching hospitals revealed higher likelihood of receiving a device at a younger age and, with Medicare/Medicaid insurance there is equal likelihood of receiving a device at public teaching institution. These findings are novel and contrary to finding in the nonstratified cohort and supported by studies comparing teaching and nonteaching hospitals.^{27,28}

4.1 Limitations

Despite the advantages of using the largest inpatient database in the United States, it still is limited by being solely classified by ICD-9 codes. Such a dataset does not contain comprehensive medical history (including echocardiographic parameters) relevant to the SSS patient. Also, we defined SSS (sinoatrial node dysfunction and atrial arrhythmias) in a way that we include a pure sample which definitely led to attenuation of sample size. However, given the power derived from current sample size directionality of relationships and trends was not affected. Also, reasons to explain temporal trends and treatment bias cannot be evaluated.

4.2 Conclusion

Using the NIS database, the present study demonstrates that inpatient PM implantations for SSS have sharply declined since 2009 and that single chamber PMs are most often used in the elderly, while the proportion of dual chamber devices are increasing. Furthermore, despite several publications from 2003 to 2007,^{6,11,12,15} gender and race disparities remain features impacting PM utilization, and clinical practice remains unchanged extending through 2013.

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FIGURE 1.

Temporal trends of patients with sick sinus syndrome who did compared to those who did not undergo pacemaker implantation in the United States from 2003 to 2013. Data are stratified by single and dual chamber devices [Color figure can be viewed at wileyonlinelibrary.com]

FIGURE 2.

Average per-capita hospital charges for with and without pacemaker implantation in sick sinus syndrome patients in the United States from 2003 to 2013 [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 1

Univariate analysis of patient and hospital data of SSS patients associated with pacemaker implantation

Characteristics	Patients Without Implantation (N = 41,258)	Patients with Implantation (N = 287,412)	P Value
Patient level			
Age(SD)	77.7 ± 10.7	77.5 ± 9.3	<0.001
Smoking, N (%)	5,777 (14.0)	40,464 (14.1)	0.35
Female, N (%)	24,219 (58.7)	15,5665 (54.2)	<0.001
<i>Race, N (%)^a</i>			
Caucasian	27,889 (67.6)	20,4968 (71.3)	<0.001
African American	2,573 (6.2)	10,271 (3.6)	
Hispanic	1,627 (3.9)	11,383 (4.0)	
Asian	884 (2.1)	5,725 (2.0)	
<i>Insurance payer, N (%)^a</i>			
Medicare/Medicaid	35,230 (85.4)	25,0038 (87.0)	<0.001
Private	4,996 (12.1)	32,173 (11.2)	
Self-pay	407 (1.0)	1,826 (0.6)	
<i>Household Income, N (%)^a</i>			
0–25th percentile	10,285 (24.9)	66,896 (23.3)	0.02
26th–50th percentile	10,889 (26.4)	76,310 (26.6)	
51th–75th percentile	9,947 (24.1)	69,742 (24.3)	
76th–100th percentile	9,327 (22.6)	69,041 (24.0)	
<i>Comorbidities</i>			
Hypertension, N (%)	29670 (71.9)	207,804 (72.3)	0.45
Coronary artery disease, N (%)	15637 (37.9)	112,284 (39.1)	0.05
Heart failure, N (%)	10137 (24.6)	58,851 (20.5)	<0.001
Chronic obstructive pulmonary disease, N (%)	7506 (18.2)	45,959 (16.0)	<0.001
Chronic renal failure, N (%)	5,678 (13.8)	29,101 (10.1)	<0.001
Comorbidity index (SD)	1.4 ± 1.9	1.1 ± 1.7	<0.001
Emergency admission, N (%)	36,234 (87.8)	198,248 (69.0)	<0.001
Admission on weekend, N (%)	9,046 (21.9)	43,415 (15.1)	<0.001
Length of stay, days (SD)	3.5 ± 2.9	3.9 ± 3.2	<0.001
Hospital level			
Public hospital, N (%)	3,408 (8.3)	18,204 (6.3)	<0.001
<i>Teaching status, N (%)^a</i>			
Rural	5,390 (13.1)	26,796 (9.3)	<0.001
Urban nonteaching	20,758 (50.3)	140,455 (48.9)	
Urban teaching	14,895 (36.1)	119,058 (41.4)	
<i>Regions, N (%)^a</i>			

Characteristics	Patients Without Implantation (N = 41,258)	Patients with Implantation (N = 287,412)	P Value
Northeast	7,001 (17.0)	57,656 (20.1)	<0.001
Midwest	9,291 (22.5)	63,430 (22.1)	
South	17,105 (41.5)	111,428 (38.8)	
West	7,861 (19.1)	54,899 (19.1)	
<i>Hospital size, N (%)^a</i>			
Small	4,959 (12.0)	27,464 (9.6)	<0.001
Middle	10,626 (25.9)	69,042 (24.0)	
Large	25,458 (61.7)	189,803 (66.0)	
Cardiology inpatient volume (SD)	10,361 ± 10,397	12,489 ± 10,873	<0.001
Cardiac procedure volume (SD)	32,902 ± 38,457	42,136 ± 42,026	<0.001

^aThe percentages do not add up to 100% due to rounding and unknown/other/missing records.

TABLE 2

Multivariate analysis of patient features of SSS patients associated with pacemaker implantation

Variable	OR (95% Confidence Interval)	P Value
<i>Age Group</i>		
18–40 years	0.46 (0.36, 0.58)	<0.001
41–65 years	0.94 (0.88, 0.99)	0.02
66–85 years	1.38 (1.33, 1.42)	<0.001
Above 85 years	1	–
Smoking	1.01 (0.97, 1.05)	0.73
Male	1.15 (1.12, 1.19)	<0.001
<i>Race</i>		
White	1.21 (1.16, 1.26)	<0.001
Non-White	1	–
<i>Insurance type</i>		
Medicare and Medicaid	1.00 (0.96, 1.06)	0.81
Private or other insurance	1	–
Hyperlipidemia	1.18 (1.14, 1.21)	<0.001
Hypertension	1.08 (1.05, 1.12)	<0.001
Coronary artery disease	0.99 (0.97, 1.02)	0.65
Chronic heart failure	0.93 (0.89, 0.96)	<0.001
Chronic obstructive pulmonary disease	0.97 (0.93, 1.01)	0.15
Chronic kidney disease	0.80 (0.77, 0.83)	<0.001
<i>Comorbidity score</i>		
Score 1 and above	0.85 (0.82, 0.89)	<0.001
Score 0	1	–
<i>Admission type</i>		
Emergency	0.31 (0.30, 0.33)	<0.001
Elective	1	–
Weekend admission	0.76 (0.73, 0.78)	<0.001
<i>Household income</i>		
0–25th percentile	0.97 (0.93, 1.01)	0.13
26–50th percentile	1.00 (0.96, 1.04)	0.89
51–75th percentile	0.96 (0.93, 1.00)	0.08
76–100th percentile	1	–
<i>Length of stay</i>		
0–3 days	0.51 (0.49, 0.52)	<0.001
Above 4 days	1	–

OR = odds ratio.

TABLE 3

Multivariate analysis of hospital features of SSS patients associated with pacemaker implantation

Variable	OR (95% Confidence Interval)	P Value
<i>Hospital ownership</i>		
Public hospital	0.89 (0.85, 0.94)	<0.001
Private hospital	1	–
<i>Teaching status</i>		
Teaching hospital	0.99 (0.96, 1.02)	0.49
Nonteaching hospital	1	–
<i>Hospital bed size</i>		
Small	0.79 (0.76, 0.83)	<0.001
Medium	1.00 (0.97, 1.04)	0.97
Large	1	–
<i>Hospital region</i>		
Midwest	0.75 (0.72, 0.79)	<0.001
South	0.78 (0.74, 0.81)	<0.001
West	0.90 (0.86, 0.94)	<0.001
Northeast	1	–
<i>Cardiac procedure volume quartiles</i>		
0–25th percentile	1	–
26–50th percentile	1.49 (1.42, 1.55)	<0.001
51–75th percentile	1.77 (1.66, 1.88)	<0.001
76–100th percentile	2.18 (1.99, 2.39)	<0.001
<i>Cardiology inpatient volume quartiles</i>		
0–25th percentile	1	–
26–50th percentile	0.92 (0.88, 0.96)	<0.001
51–75th percentile	0.86 (0.81, 0.92)	<0.001
76–100th percentile	0.83 (0.76, 0.91)	<0.001

OR = odds ratio.

TABLE 4

Odds ratios of pacemaker implantation by multivariate analysis stratified by gender

Variable	Gender		P Value ^a
	Male	Female	
<i>Age group</i>			<0.001
18–40 years	0.55 (0.40, 0.76)	0.26 (0.18, 0.39)	
41–65 years	0.75 (0.69, 0.81)	1.11 (1.02, 1.21)	
66–85 years	1.12 (1.06, 1.19)	1.53 (1.47, 1.59)	
Above 85 years	1	1	
<i>Race</i>			0.004
White	1.31 (1.23, 1.39)	1.16 (1.10, 1.22)	
Non-White	1	1	
<i>Insurance type</i>			<0.001
Medicare and Medicaid	1.13 (1.05, 1.21)	0.87 (0.80, 0.93)	
Private or other insurance	1	1	
<i>Comorbidity score</i>			0.006
Score 1 and above	0.91 (0.86, 0.97)	0.81 (0.77, 0.86)	
Score 0	1	1	
<i>Household income</i>			0.12
0–25th percentile	0.96 (0.90, 1.02)	0.97 (0.92, 1.03)	
26–50th percentile	1.03 (0.97, 1.10)	0.97 (0.92, 1.02)	
51–75th percentile	0.99 (0.93, 1.06)	0.94 (0.89, 0.99)	
76–100th percentile	1	1	
<i>Hospital ownership</i>			<0.001
Public	0.99 (0.92, 1.06)	0.83 (0.78, 0.89)	
Private	1	1	
<i>Hospital teaching status</i>			0.64
Teaching	0.98 (0.93, 1.03)	0.99 (0.95, 1.04)	
Nonteaching	1	1	
<i>Hospital size</i>			<0.001
Small	0.90 (0.84, 0.97)	0.72 (0.68, 0.77)	
Medium	1.09 (1.03, 1.15)	0.94 (0.90, 0.99)	
Large	1	1	
<i>Hospital cardiac procedure volume</i>			0.003
0–25th percentile	1	1	
26–50th percentile	1.40 (1.32, 1.50)	1.55 (1.46, 1.64)	
51–75th percentile	1.83 (1.67, 2.02)	1.74 (1.60, 1.88)	
76–100th percentile	2.09 (1.82, 2.40)	2.30 (2.03, 2.60)	

^aThe P values are the results of the tests for interaction between sex and patient level characteristics.

TABLE 5

Odds ratios of pacemaker implantation by multivariate analysis stratified by race

Variable	Race		P Value ^a
	Non-white	White	
<i>Age group</i>			0.001
18–40 years	0.52 (0.34, 0.79)	0.46 (0.34, 0.62)	
41–65 years	1.16 (1.02, 1.33)	0.89 (0.83, 0.95)	
66–85 years	1.58 (1.44, 1.72)	1.35 (1.30, 1.40)	
Above 85 years	1	1	
<i>Gender</i>			
Male	1.01 (0.93, 1.09)	1.18 (1.14, 1.22)	<0.001
Female	1	1	
<i>Insurance type</i>			0.36
Medicare and Medicaid	0.95 (0.84, 1.07)	1.01 (0.96, 1.07)	
Private or other insurance	1	1	
<i>Comorbidity score</i>			<0.001
Score 1 and above	0.67 (0.61, 0.74)	0.89 (0.85, 0.93)	
Score 0	1	1	
<i>Household income</i>			<0.001
0–25th percentile	0.80 (0.71, 0.89)	1.02 (0.98, 1.07)	
26–50th percentile	0.87 (0.77, 0.97)	1.02 (0.98, 1.07)	
51–75th percentile	0.97 (0.86, 1.09)	0.96 (0.92, 1.01)	
76–100th percentile	1	1	
<i>Hospital ownership</i>			0.61
Public	0.87 (0.77, 0.97)	0.89 (0.85, 0.94)	
Private	1	1	
<i>Hospital teaching status</i>			<0.001
Teaching	0.77 (0.71, 0.85)	1.04 (1.00, 1.08)	
Nonteaching	1	1	
<i>Hospital size</i>			0.10
Small	0.87 (0.76, 0.99)	0.79 (0.75, 0.83)	
Median	0.95 (0.87, 1.04)	1.01 (0.97, 1.05)	
Large	1	1	
<i>Hospital cardiac procedure volume</i>			0.003
0–25th percentile	1	1	
26–50th percentile	1.39 (1.24, 1.55)	1.50 (1.43, 1.57)	
51–75th percentile	2.05 (1.74, 2.43)	1.74 (1.62, 1.86)	
76–100th percentile	2.06 (1.61, 2.64)	2.21 (2.00, 2.44)	

^aThe P values are the results of the tests for interaction between race and patient or hospital level characteristics.

TABLE 6

Odds ratios of pacemaker implantation by multivariate analysis stratified by insurance

Variable	Insurance Type		P value ^a
	Medicare/Medicaid	Private/Other	
<i>Age group</i>			<0.001
18–40 years	0.23 (0.16, 0.34)	0.85 (0.60, 1.20)	
41–65 years	0.95 (0.88, 1.02)	1.11 (0.96, 1.29)	
66–85 years	1.37 (1.32, 1.41)	1.56 (1.34, 1.82)	
Above 85 years	1	1	
<i>Gender</i>			
Male	1.20 (1.16, 1.24)	0.87 (0.80, 0.95)	<0.001
Female	1	1	
<i>Race</i>			0.40
White	1.22 (1.17, 1.27)	1.16 (1.03, 1.30)	
Non-White	1	1	
<i>Comorbidity score</i>			<0.001
Score 1 and above	0.83 (0.79, 0.86)	1.06 (0.94, 1.20)	
Score 0	1	1	
<i>Household income</i>			<0.001
0–25th percentile	0.94 (0.90, 0.99)	1.13 (1.00, 1.28)	
26–50th percentile	0.96 (0.92, 1.00)	1.24 (1.11, 1.39)	
51–75th percentile	0.94 (0.90, 0.98)	1.13 (1.00, 1.26)	
76–100th percentile	1	1	
<i>Hospital ownership</i>			0.83
Public	0.89 (0.85, 0.93)	0.90 (0.78, 1.05)	
Private	1	1	
<i>Hospital teaching status</i>			0.71
Teaching	0.99 (0.96, 1.03)	1.01 (0.92, 1.11)	
Nonteaching	1	1	
<i>Hospital size</i>			0.05
Small	0.79 (0.76, 0.84)	0.76 (0.66, 0.87)	
Median	1.01 (0.98, 1.05)	0.88 (0.80, 0.98)	
Large	1	1	
<i>Hospital cardiac procedure volume</i>			0.003
0–25th percentile	1	1	
26–50th percentile	1.48 (1.41, 1.55)	1.45 (1.27, 1.66)	
51–75th percentile	1.80 (1.68, 1.92)	1.49 (1.23, 1.79)	
76–100th percentile	2.32 (2.10, 2.56)	1.42 (1.09, 1.86)	

^aThe P values are the results of the tests for interaction between insurance type and patient or hospital level characteristics.

TABLE 7

Odds Ratios of pacemaker implantation by multivariate analysis stratified by teaching hospital

Variable	Hospital Teaching Status		P Value ^a
	Teaching	Nonteaching	
<i>Age Group</i>			<0.001
18–40 years	0.52 (0.35, 0.77)	0.44 (0.32, 0.59)	
41–65 years	1.09 (0.99, 1.21)	0.88 (0.82, 0.94)	
66–85 years	1.55 (1.46, 1.64)	1.32 (1.27, 1.37)	
Above 85 years	1	1	
<i>Gender</i>			
Male	1.10 (1.04, 1.16)	1.17 (1.13, 1.21)	0.07
Female	1	1	
<i>Race</i>			<0.001
White	1.49 (1.39, 1.59)	1.08 (1.03, 1.14)	
Non-White	1	1	
<i>Insurance type</i>			0.002
Medicare and Medicaid	1.12 (1.03, 1.22)	0.95 (0.89, 1.01)	
Private or other insurance	1	1	
<i>Comorbidity score</i>			0.67
Score 1 and above	0.87 (0.81, 0.93)	0.85 (0.81, 0.89)	
Score 0	1	1	
<i>Household income</i>			0.30
0–25th percentile	0.93 (0.86, 1.00)	1.01 (0.96, 1.06)	
26–50th percentile	0.98 (0.91, 1.05)	1.02 (0.98, 1.07)	
51–75th percentile	0.93 (0.87, 1.00)	0.99 (0.94, 1.04)	
76–100th percentile	1	1	
<i>Hospital ownership</i>			0.05
Public	0.97 (0.88, 1.07)	0.87 (0.82, 0.92)	
Private	1	1	
<i>Hospital size</i>			<0.001
Small	0.86 (0.79, 0.94)	0.76 (0.72, 0.81)	
Median	1.16 (1.09, 1.24)	0.96 (0.92, 1.00)	
Large	1	1	
<i>Hospital cardiac procedure volume</i>			0.49
0–25th percentile	1	1	
26–50th percentile	1.45 (1.33, 1.59)	1.48 (1.41, 1.56)	
51–75th percentile	1.72 (1.50, 1.96)	1.84 (1.71, 1.98)	
76–100th percentile	2.13 (1.80, 2.52)	2.49 (2.22, 2.80)	

^aThe P values are the results of the tests for interaction between insurance type and patient or hospital level characteristics.