Impact of atrial fibrillation on in-hospital outcomes among hospitalizations for cardiac surgery: an analysis of the National Inpatient Sample

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ABSTRACT

The short-term impact of atrial fibrillation (AF) on cardiac surgery hospitalizations has been previously reported in cohorts of various sizes, but results have been variable. Using the 2005–2014 National Inpatient Sample, we identified all adult hospitalizations for cardiac surgery using the International Classification of Diseases, Ninth Revision, Clinical Modification as any procedure code and AF as any diagnosis code. We estimated the impact of AF on inpatient mortality, length of stay (LOS), and cost of hospitalization using survey-weighted, multivariable logistic, accelerated failure-time log-normal, and log-transformed linear regressions, respectively. Additionally, we exact-matched AF to non-AF hospitalizations on various confounders for the same outcomes. A total of 1,269,414 hospitalizations were noted for cardiac surgery during the study period. Coexistent AF was found in 44.9% of these hospitalizations. Overall mean age was 65.6 years, 40.9% were female, mean LOS was 11.6 days, and inpatient mortality was 4.5%. Stroke rate was lower in AF hospitalizations (1.8% vs 2.1%, p<0.001). Mortality was lower in the AF (3.9%) versus the non-AF (5%) group (exact-matched OR or emOR=0.48, 95% CI 0.29 to 0.80, p<0.001; 987 matched pairs, n=2423), with similar results after procedural stratification: isolated valve replacement/repair (emOR=0.38, p<0.001), isolated coronary artery bypass graft (CABG) (emOR=0.33, p<0.001), and CABG with valve replacement/repair (emOR=0.55, p<0.001). A 12% increase was seen in LOS in the AF subgroup (exact-matched time ratio=1.12, 95% CI 1.10 to 1.14, p<0.001) among hospitalizations which underwent valve replacement/repair with or without CABG. Hospitalizations for cardiac surgery which had coexistent AF were found to have lower inpatient mortality risk and stroke prevalence but higher LOS and hospitalization costs compared with hospitalizations without AF.

Significance of this study

What is already known about this subject?

- Atrial fibrillation is the most common rhythm disorder among US patients hospitalized with a primary diagnosis of an arrhythmia.
- The prevalence of atrial fibrillation in patients undergoing cardiac surgery is increasing and it is the most common arrhythmias postcardiac surgery.
- It is, however, unclear if patients with coexistent atrial fibrillation are at high risk of in-hospital mortality and prevalence of stroke in hospitalizations for cardiac surgery.

What are the new findings?

- Atrial fibrillation does not increase inpatient mortality in hospitalizations for cardiac surgery and this could be due to the effect of anticoagulant therapy that patients with atrial fibrillation received.
- Cardiac surgery hospitalized patients with atrial fibrillation had increased odds of higher length of stay and hospitalization costs compared with hospitalizations without atrial fibrillation.

How might these results change the focus of research or clinical practice?

- Further studies comparing the odds of stroke in cardiac surgery patients with and without anticoagulation are needed.

INTRODUCTION

Atrial fibrillation (AF) is the most common rhythm disorder among US patients hospitalized with a primary diagnosis of an arrhythmia.[1] The prevalence of AF increases with age, ranging from 0.1% among adults less than 55 years of age to 9% in those ≥80 years of age.[2] Due to improved pharmacological treatments and aging of the general population, surgeons are increasingly operating on elderly patients.[3] As a result, the prevalence of AF in patients undergoing cardiac surgery is also increasing.

Moreover, AF is the most common arrhythmias postcardiac surgery.[4]

While multiple studies have been conducted on hospitalizations for cardiac surgery with or without valve repair with coexisting AF, the impact of AF on short-term outcomes has been conflicting. Some studies showed AF is associated with high mortality,[5–9] while no significant impact of AF on outcome was found in other studies.[10–14] Therefore, we studied the impact of AF on mortality and morbidity in hospitalizations for cardiac surgery in one of the largest cohorts on hospitalizations, the National Inpatient Sample (NIS). The primary aim of this study was to evaluate in-hospital mortality in hospitalizations for cardiac surgery with and without AF. Secondary endpoints were complication rates, length of hospital stay, and total cost of hospitalization.

METHODS

Data source and design

We designed a retrospective observational cohort study using the Healthcare Cost and Utilization Project (HCUP) NIS database, which is sponsored by the Agency for Healthcare Research and Quality (AHRQ).[15] The time of the study included the years 2005–2014. The years 2005–2011 included data from 37 to 46 states, which make up all discharges from a 20% sample of all hospitals (approximately 1000 hospitals). Since 2012, the NIS has underwent a redesign to include a systematic random sample of 20% of all discharges from all acute care hospitals (over 4000 hospitals). Both designs accrued approximately 20% of the target universe of discharges from US acute care hospitals, excluding rehabilitation and long-term acute care hospitals. This sample averages seven million discharges every year, representing over 95% of the US population. Details regarding the design and validity of the NIS have been described previously.[16]

Study population

We included all adults (age ≥18 years) with International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes (see online supplemental table 1) for cardiac surgery in procedure variables (PR1–PR15). AF was identified with the ICD-9-CM code 427.31 in any discharge diagnosis fields (DX1–DX25). This code has been validated previously.[17 18] Hospitalizations with missing information on age, gender, or inpatient mortality were excluded.

Variables

Demographic variables including age, gender, race, household income per hospitalization zip code, as well as hospitalization-related variables of insurance, bed size, region, teaching status, and location (urban vs rural) are readily available in the NIS database. Comorbidities were identified using the AHRQ Elixhauser variables already available in the NIS. Acute kidney injury (AKI) was split into a three-category variable (no AKI, AKI without dialysis, AKI with dialysis). ICD-9-CM codes for AKI and dialysis were used, as previously mentioned.[18] Moderate-to-severe disability on discharge was determined from the DISPUNIFORM (disposition of patient, uniform coding), being equal to the values of 2, 5, or 6, representing transfers to short-term hospital, skilled nursing facility, intermediate care facility, and home healthcare. The number of diagnostic/operative procedures was extracted from the number of procedures (NPR) variable.

Hospitalization costs were calculated by multiplying the cost to charge ratios provided by HCUP by the TOTCHG variable (total charges), subsequently weighted for missing values and finally adjusted for annual inflation, with the reference year 2014.[19] Charlson Comorbidity Index (CCI) was calculated for each observation as outlined in Gordon and Quan *et al*.[20–22]

Statistical analyses

Bivariate, weighted comparisons were conducted between AF and non-AF groups using t-test and χ^2 test for continuous and categorical variables, respectively. In the case of multicategorical variables (eg, primary payer, race), additional z-tests for proportions were done, with the p value adjusted with Bonferroni correction for multiple comparisons. In the case of multicategorical variables with logical ordering (eg, AKI, income quartiles), the Cochran-Armitage test for trend was used.

Trends were assessed using multivariate regression, with year normalized from 0 to 9, acting as a continuous covariate. AF prevalence was adjusted for age, gender, and CCI. Mortality trends were additionally adjusted for hospital variables while using mixed models with hospital identification as the random intercept. Length of stay (LOS) was additionally adjusted for the number of diagnostic/operative procedures.

To assess the independent effect of AF on hospitalization outcomes while avoiding issues such as overfitting, misspecification, and multicollinearity potentially found in a regression analysis, we opted to run matched analyses. For all matched analyses, the AF hospitalizations were matched with non-AF cases using the *exact* same hospital, calendar year, age, admission status (elective vs non-elective), and CCI. Additionally, coarse matching (ie, matched groups of a continuous variable) for the number of diagnostic/operative procedures was included. We used the ‘cem’ module[23] to determine the matched groups. Subsequently, a double-robust regression was used, which included the matching variables (for capturing any residual variability in coarse matching), as well as additional confounders that should have been matched but would result in a very low number of matched pairs. Inpatient mortality was fitted with a mixed-effects logistic regression model. Hospitalization costs were regressed using mixed-effects linear regression. LOS was regressed using an accelerated failure-time model using a log-normal distribution, where inpatient deaths are censored and alive hospitalizations represent a discharge event. This method is not bound by the proportional hazard assumptions such as in Cox regression, and its results are intuitively interpreted as time ratios (TR), where a TR >1 means longer LOS and vice versa. All of the double-robust regression models that used weights produced by the matching algorithm included only the matched observations, and the random intercept was the matched group identification. The matching analyses were repeated in three subgroups to control for the type of procedure done:

coronary artery bypass graft (CABG) only, valve repair/replacement only, and combined CABG and valve repair/replacement. These subgroups were determined as the ones with the majority of the procedures in our study population. Any corresponding procedure codes documented in PR1 to PR3 (our threshold for 'primary' procedures for each hospitalization) were included in the respective subgroup.

National estimates were calculated using the trend weight (TRENDWT) variable, as recommended by HCUP,[24] while additionally adjusting for potentially missing hospitals from the cardiac surgery subpopulation. Complex survey design commands ('svy') were used to account for the NIS complex survey design, as recommended by HCUP[25 26] for non-matched analyses. P values were considered significant a priori as <0.05. All analyses were performed in Stata MP V.14.2.

RESULTS

We identified 1,269,414 hospitalizations for cardiac surgery between the years 2005 and 2014. Valve repair/replacement alone (57%) and CABG combined with valve repair/replacement (25.8%) were the most frequent procedures performed. We found a higher prevalence of coexistent AF in hospitalizations for CABG procedure, and no major clinical difference was found in the prevalence of AF in hospitalizations undergoing CABG combined with valve repair/replacement or valve repair/replacement alone (table 1, figure 1).

The prevalence of AF in hospitalizations for cardiac surgery was 44.8% in 2005 and 48% in 2014. However, no uniform trend was noted for this overall rise in the incidence of AF from 2005 to 2014. Inpatient mortality among AF hospitalizations improved from 2005 to 2008 (from 5.2% to 3.2%) and was stable at around 3.6% from 2009 to 2014. Mortality among cardiac surgery hospitalizations trended down from 5.2% to 4% from 2005 to 2014. We also noted an increase in the mean Charlson comorbidity score among hospitalizations for cardiac surgery during the study period, from 1.29 in 2005 to 1.75 in 2014 (table 2).

Hospitalization characteristics

The demographics, comorbidities, in-hospital characteristics, and procedures performed are summarized in table 1. Among hospitalizations for cardiac surgery from 2005 to 2014, 44.9% had coexistent AF. Hospitalizations with AF were older (mean age 70 years vs 62 years, p<0.001), more likely to be male (59.5% vs 58.8%, p=0.001), and Caucasians (84.1% vs 77.7%, p<0.001) compared with hospitalizations without AF. Hospitalizations with AF were more likely to have Medicare (68% vs 49.5%, p<0.001) and have higher incidence of comorbidities such as hypertension (64.5% vs 57.9%, p<0.001), diabetes (25.3% vs 23.6%, p<0.001), chronic lung disease (21.9% vs 18.6%, p<0.001), electrolyte abnormalities (32.1% vs 27.4%, p<0.001), and higher CCI (1.67 vs 1.36, p<0.001) than hospitalizations without AF. Hospitalizations with and without AF did not differ significantly from each other in terms of income and region of the hospital where procedures were performed and other comorbid conditions such as peripheral vascular disease, pulmonary hypertension, and malignancy. Most of the surgeries were performed at large (76%), teaching (69.7%), and urban (97%) hospitals (table 1).

Outcomes

Inpatient mortality among hospitalizations undergoing cardiac surgery was lower in hospitalizations with AF compared with without AF (3.9% vs 5%, p<0.001). The OR for in-hospital mortality for hospitalizations with CABG was 0.33 (95% CI 0.17 to 0.65, p<0.001), the OR for hospitalizations with valve repair/replacement was 0.38 (95% CI 0.31 to 0.46, p<0.001), the OR for hospitalizations with both CABG and valve repair/replacement was 0.55 (95% CI 0.43 to 0.72, p<0.001), and the overall OR for all surgical procedures was 0.48 (95% CI 0.29 to 0.80, p<0.001) (figure 2).

The overall rate of reported hospitalization diagnosis of stroke was 2.0%. AF hospitalizations had a lower rate of stroke than hospitalizations without AF (1.8% vs 2.1%, respectively, p<0.001). Hospitalization undergoing CABG alone had higher rates of stroke (2.1% in AF, 2.6% without AF) compared with those undergoing valve surgery alone (1.8% with and without AF). There was an increasing trend of stroke during the study period: 1.3% in 2005 and 2.1% in 2014.

The overall rate of AKI was 16.8% (15% had AKI and did not require dialysis, while 1.8% developed AKI that needed dialysis). Hospitalization undergoing cardiac surgery who had coexistent AF had higher rates of AKI compared with hospitalization without AF (18.3% vs 15.6%, p<0.001).

Overall, hospitalizations with AF had 4% increased LOS, with a mean stay of 12.2 days, compared with 11.1 days in hospitalizations without AF (OR1.04, 95% CI 1.00 to 1.08, p=0.069). Subgroup analysis revealed that in valve replacement/repair-only cases, LOS was longer by 9% (OR 1.09, 95% CI 1.08 to 1.10, p<0.001), in combined CABG and valve procedure surgeries longer by 12% (OR 1.12, 95% CI 1.10 to 1.14, p<0.001), and in CABG-only cases 7% shorter (OR 0.93, 95% CI 0.88 to 0.97, p=0.003) for AF hospitalizations when compared with those without AF (figure 3).

Hospitalization costs were also higher in hospitalizations for cardiac surgery who had AF as compared with hospitalizations without AF ($61,012 vs $58,065, p<0.001). Overall, hospitalizations with AF had 1% greater hospitalization cost compared with those without AF (OR 1.01, 95% CI 1.001 to 1.026, p=0.034). Subgroup analysis revealed that, when compared with hospitalizations without AF, hospitalizations with AF had 2% higher cost in valve replacement/repair surgeries either with or without CABG (OR 1.02, 95% CI 1.011 to 1.022, p<0.001 for valve replacement/repair-only surgeries; OR 1.02, 95% CI 1.01 to 1.03, p<0.001 for valve surgery with CABG). The cost was similar in AF and non-AF hospitalizations undergoing CABG alone (OR 1.00, 95% CI 0.98 to 1.03, p=0.824).

DISCUSSION

Using data from 2005 to 2014 from the largest inpatient database, we found that (1) the prevalence of AF among hospitalizations for cardiac surgery increased in the period from 2005 to 2014; (2) cardiac surgery hospitalization with coexistent AF had lower inpatient mortality compared

Table 1 Baseline characteristics of patients undergoing cardiac surgery

Variable	Atrial fibrillation No	Atrial fibrillation Yes	Overall	P value	Test
	% or mean				
Cardiac surgery patients (N=1,269,414)	55.1	44.9			
Mean age (years)	62	70	65.6	<0.001	t-test
Mean CCI	1.36	1.67	1.5	<0.001	t-test
Mean LOS (days)	11.1	12.2	11.6	<0.001	t-test
Mean cost (US$)	58,065	61,012	59,398	<0.001	t-test
Female	41.2	40.5	40.9	0.001	χ^2
Primary payer					
Medicare	49.5	68	57.8	<0.001	z-test
Medicaid	7.5	3.8	5.8	<0.001	z-test
Private	37.1	24.8	31.5	<0.001	z-test
Self-pay	2.9	1.6	2.3	<0.001	z-test
No charge	0.4	0.2	0.3	0.392	z-test
Other	2.7	1.7	2.3	<0.001	z-test
Race					
White	77.7	84.1	80.6	<0.001	z-test
Black	8.6	4.9	6.9	<0.001	z-test
Hispanic	7.5	5.1	6.4	<0.001	z-test
Asian/Pacific Islander	2	2.2	2.1	0.275	z-test
Native American	0.7	0.5	0.6	0.297	z-test
Other	3.5	3.2	3.4	0.08	z-test
Income					
0–25th percentile	23.4	21	22.3	<0.001 (increasing income in atrial fibrillation)	Cochran-Armitage
26th–50th percentile (median)	25.6	25.4	25.5		
51st–75th percentile	25.5	26.1	25.8		
76th–100th percentile	25.5	27.5	26.4		
Moderate-to-severe disability on discharge	53.7	65.6	59	<0.001	χ^2
In-hospital death	5	3.9	4.5	<0.001	χ^2
No acute kidney injury	84.4	81.7	83.2	<0.001 (worsening renal function)	Cochran-Armitage
Acute kidney injury without dialysis	13.9	16.4	15		
Acute kidney injury with dialysis	1.8	1.9	1.8		
Stroke	2.1	1.8	2	<0.001	χ^2
Congestive heart failure	2.3	2.2	2.3	0.612	χ^2
Chronic lung disease	18.6	21.9	20.1	<0.001	χ^2
Pulmonary hypertension	0.9	0.8	0.9	0.059	χ^2
Hypertension	57.9	64.5	60.8	<0.001	χ^2
Peripheral artery disease	14.4	14.1	14.3	0.106	χ^2
Electrolyte disorder	27.4	32.1	29.5	<0.001	χ^2
Metastatic cancer	0.5	0.4	0.5	0.229	χ^2
Obesity	12.5	13.3	12.9	<0.001	χ^2
Valve disease	2.1	1.9	2	0.012	χ^2
Diabetes mellitus	23.6	25.3	24.4	<0.001	χ^2
Weekend admission	7.3	7	7.2	0.022	χ^2
Elective admission	63	64.8	63.8	<0.001	χ^2
Hospital region					
Northeast	22.3	22.1	22.2	0.205	z-test
Midwest	24.5	25.7	25	<0.001	z-test
South	33.6	32.4	33.1	<0.001	z-test
West	19.5	19.8	19.7	0.089	z-test
Teaching hospital	70.4	68.8	69.7	<0.001	χ^2
Urban hospital	97	97	97	0.847	χ^2
Hospital bed size					

Continued

Table 1 Continued

Variable	Atrial fibrillation No	Atrial fibrillation Yes	Overall	P value	Test
	% or mean				
Small	6.1	6.4	6.2	<0.001 (increasing bed size in atrial fibrillation)	Cochran-Armitage
Medium	17.5	18	17.8		
Large	76.3	75.6	76		
Procedures (variables PR1–PR3)					
CABG only	3.1	7.1	4.9	<0.001	z-test
Valve repair/replacement only	56.7	57.5	57	<0.001	z-test
CABG with valve repair/replacement	25.6	26.2	25.8	<0.001	z-test
Other procedures PR1–PR3	14.7	9.1	12.2	<0.001	z-test

CABG, coronary artery bypass graft; CCI, Charlson Comorbidity Index; LOS, length of stay.

with hospitalizations without AF; (3) cardiac surgery hospitalizations with coexistent AF had a lower rate of stroke compared with hospitalizations without AF; (4) hospitalizations for valve repair/replacement alone or CABG with valve repair/replacement who had coexistent AF had a longer LOS compared with a similar cohort without AF; and (5) hospitalizations for valve repair/replacement alone or CABG with valve repair/replacement with coexisting AF had higher hospitalization costs compared with a similar cohort without AF.

As mentioned earlier, the short-term impact of AF on hospitalizations undergoing cardiac surgery has been studied previously with conflicting results; hence, the impact of AF on morbidity and mortality remains unclear. Quader *et al*[5] conducted a study including 46,984 patients who underwent CABG at Cleveland Clinic from 1972 to 2000. In propensity-matched hospitalizations, survival at 30 days and at 5 and 10 years for patients with AF was lower than those without AF.[5] Using data collected from the Society of Thoracic Surgeons (STS) database, LaPar *et al*[6] conducted a study in 49,264 patients who underwent cardiac surgery from 2001 to 2012. After risk adjustment, postoperative AF was associated with a twofold increase in the odds of mortality, greater hospital resource utilization, and increased costs.[6] Anghel *et al*[7] reviewed 10 years of data from a single center and reported that patients undergoing heart surgery with AF had significantly higher mortality and major complications following surgery. A single prospective center study in Italy showed that postoperative AF affects early and late mortality after CABG.[8] Another large prospective cohort observational study using data from the STS National Adult Cardiac Surgery Database of 281,567 patients who underwent CABG from 2002 to 2003 found that preoperative AF was associated with an increased risk of perioperative mortality and morbidity in patients undergoing CABG.[9]

Kalavrouziotis *et al*[10] studied 7347 patients undergoing CABG alone or combined with valve surgery. New-onset AF was not an independent predictor of in-hospital mortality. Propensity-adjusted results revealed no difference in in-hospital mortality between new-onset AF compared with those without AF.[10] Another interesting study conducted by Ngaage *et al*[11] included 4151 patients undergoing CABG from 1993 to 2002. Operative mortality was similar in patients with preoperative AF compared with patients in sinus rhythm. Patients with AF had more extended hospital stays and higher early readmission rates. The risk of late mortality (all causes) in patients with AF was higher by 40% compared with patients in sinus rhythm, and the late cardiac death rate in the AF group was 2.8 times that of the sinus rhythm group.[11] Similarly, Bramer *et al*,[12] from their prospective analysis of 5098 patients, found postoperative AF was not an independent predictor of early mortality but did predict overall and late mortality in patients after isolated CABG. In an interesting study on 162 patients, preoperative AF in patients undergoing mitral valve surgery

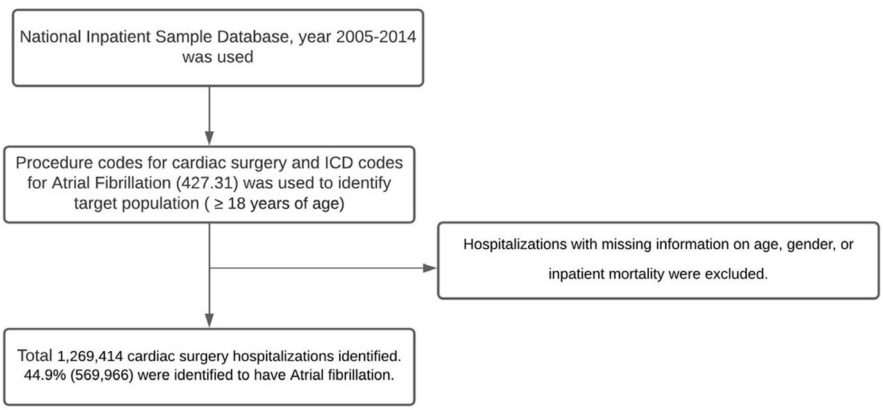

Figure 1 Population derivation figure. ICD, International Classification of Diseases.

Table 2 Trends of AF prevalence, mortality, LOS, and costs in patients undergoing cardiac surgery (2005–2014)

Variables	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	P trend
Prevalence of AF among cardiac surgery patients (%)	44.8	45.4	45.7	39.4	43.8	41.5	46.5	46.6	47.1	48.0	<0.001 Increasing
Inpatient mortality in cardiac surgery patients with coexistent AF (%)	5.2	5.3	4.7	3.2	3.6	3.4	3.6	3.4	3.4	3.5	<0.001 Decreasing
Inpatient mortality among cardiac surgery patients (%)	5.2	5.3	4.8	5.0	4.3	4.4	4.2	4.1	4.1	4.0	<0.001 Decreasing
LOS in cardiac surgery patients	12.1	11.7	11.9	11.7	11.5	11.2	11.5	11.5	11.4	11.4	<0.001 Decreasing
Hospital costs in US$ in cardiac surgery patients*	59,345	52,735	56,792	58,846	58,744	66,990	64,350	59,633	59,236	58,833	0.843 No trend
CCI in cardiac surgery†	1.29	1.34	1.37	1.32	1.46	1.53	1.53	1.67	1.67	1.75	<0.001 Increasing

All other outcomes apart from costs have been adjusted for age, gender, CCI, and hospital variables. LOS trend analysis was additionally adjusted for number of procedures. Trends for inpatient mortality, LOS, and costs were analyzed using mixed models with hospital identification–year as random intercepts.
*Cost trends were further adjusted only with hospital variables.
†CCI trend was analyzed without mixed models as it describes comorbidities presumably not associated with current hospitalization, while correcting for age and gender.
AF, atrial fibrillation; CCI, Charlson Comorbidity Index; LOS, length of stay.

did not impact survival, whereas patients undergoing mitral valve surgery with postoperative AF had slightly worse survival.[12] In a retrospective analysis of patients undergoing aortic valve replacement (AVR) between June 2001 and December 2009 using data from the Australasian Society of Cardiac and Thoracic Surgeons National Cardiac Surgery Database Program, postoperative AF was a risk factor for short-term morbidity but was not associated with a higher rate of early or late mortality after isolated AVR.[14]

In a large study based on the California Patient Discharge Database, the overall 30-day rate of stroke in patients undergoing CABG with chronic AF was 3.1% vs 2% in patients without AF. In the same study, the rate of stroke for cardiac valve replacement was similar (3% vs 2.3%).[27] Hogue *et al*[28] analyzed data obtained from 2972 patients who underwent CABG or valve surgery. Strokes occurred in 1.6% of patients and AF had no impact on postoperative stroke rate unless it was accompanied by low cardiac output syndrome. In another study, prospective data from 16,184 patients undergoing cardiac surgery revealed an overall incidence of stroke as high as 4.6%.[29] Almassi *et al*,[30] in their study on 4941 patients undergoing cardiac surgery, reported an overall stroke of 3.4% (varied from 1.7% to 9% between participating institutions). CABG was associated with a stroke prevalence of 2.8%, while AVR had a stroke prevalence of 1.8%. Libman *et al*[31] reported a stroke rate of 2% from their data on 2211 patients who underwent cardiac

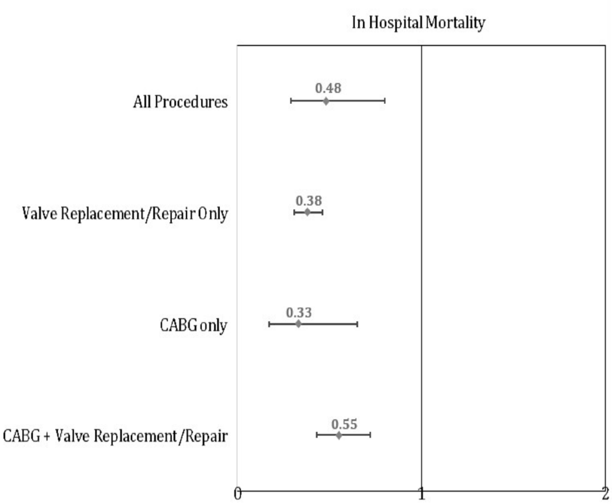

Figure 2 Effect of atrial fibrillation on in-hospital mortality. CABG, coronary artery bypass graft.

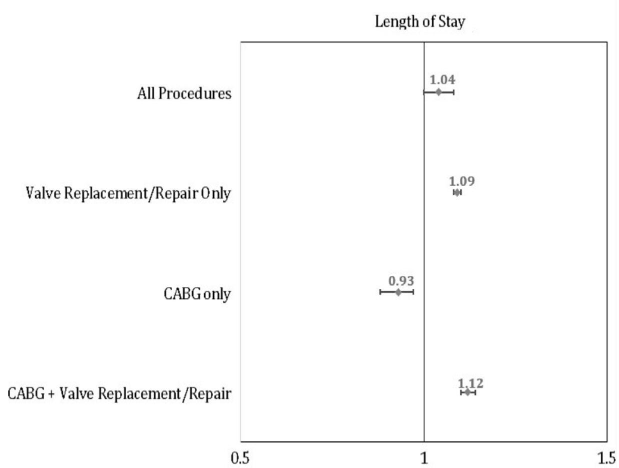

Figure 3 Effect of atrial fibrillation on length of stay. CABG, coronary artery bypass graft.

surgery. The overall rate of stroke in our study was 2%, which is similar to that reported by most previous studies. Cardiac surgery patients with coexistent AF were found to have a lower prevalence of stroke than those without AF in our study. This could be due to the effect of anticoagulant therapy that patients with AF received.

Our study results are in agreement with previous studies regarding LOS and hospitalization costs in hospitalizations for cardiac surgery who had coexistent AF. In our study, hospitalization with AF had a significantly higher incidence of AKI compared with those without AF. Development of potentially postoperative AF or coexisting AF and its management, including bridging of anticoagulation, might have added to increased LOS as observed in our study. AF hospitalizations were also found to have a higher CCI than hospitalizations without AF. This has been shown to increase the total cost of hospitalization, mainly due to increased LOS in these hospitalizations.[32 33]

Limitations

One of the main strengths of this study is the large sample size. Our study includes 1,269,414 hospitalizations, one of the largest studies conducted for prognostic significance of AF among cardiac surgery hospitalizations. The hospitalizations were enrolled in the database for over 10 years. NIS is the largest, publicly available, all-payer inpatient database representing >95% of the US inpatient population. Thus, the results are pooled over a long time in multiple institutions across the USA.

Several limitations should be discussed. First, the NIS is a de-identified administrative database, making it impossible to validate specific ICD-9 codes. This significantly affects the sensitivity and specificity when applying the diagnostic codes. One patient may be hospitalized multiple times; therefore, the study results may not be extrapolated to individual patients. Studies based on data mining are susceptible to errors related to coding. Besides, with NIS, it is not possible to know which hospitalizations had a diagnosis of AF from before the surgery and which hospitalizations developed AF postoperatively. Furthermore, the retrospective observational nature of the study carries an inherent risk of selection bias and confounding that might have contributed to the reporting of adverse effects. The administrative data used in this analysis lack the detail that is available in trials and registries, such as diagnostic imaging tests and medications. Characteristics and a full assessment of comorbidities (ie, including outpatient diagnoses) were unavailable for the analyses. However, this limitation is counterbalanced by the larger sample size and the absence of reporting bias introduced by selective publication of results from specialized centers. Additionally, this study does not provide a detailed analysis of the impact of various demographic characteristics on AF cardiac surgery patients.

CONCLUSION

Hospitalizations for cardiac surgery who had coexistent AF were found to have lower inpatient mortality risk and stroke prevalence compared with hospitalizations without AF. There were increased LOS and hospitalization costs in hospitalizations with AF compared with hospitalizations without AF, which is in agreement with previous studies. In hospitalizations with AF undergoing cardiac surgery, it could be reasonable to implement preventive and early interventions to reduce the impact on healthcare utilization. This quantitative study provides valuable and hypothesis-generating results, as well as considerations for future research.

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