Impact of Concomitant Ablation of Non-Paroxysmal Atrial Fibrillation during Coronary Artery Bypass Grafting on Mortality and Readmissions

2016-2018 Nationwide Readmissions Database

- Use of surgical ablation of atrial fibrillation during CABG remains low.
- Surgical ablation during CABG did not affect length of stay, mortality, or short-term readmissions.
- These findings support increased use of surgical AF ablation during CABG.

AF, atrial fibrillation; CABG, coronary artery bypass grafting
Impact of concomitant ablation of non-paroxysmal atrial fibrillation during coronary artery bypass grafting on mortality and readmissions

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Abbreviations and Acronyms

ACSD = Adult Cardiac Surgery Database
AF = atrial fibrillation
CABG = coronary artery bypass grafting
CI = confidence interval
HR = hazard ratio
ICD-10-CM = International Classification of Diseases, Tenth Revision, Clinical Modification
LOS = length of stay
NRD = Nationwide Readmissions Database
SA = surgical ablation
STS = Society of Thoracic Surgeons
CENTRAL PICTURE LEGEND

One-year readmission after CABG in patients with non-paroxysmal atrial fibrillation

CENTRAL MESSAGE

Despite its safety, surgical ablation in patients with non-paroxysmal atrial fibrillation undergoing coronary artery bypass grafting has a low utilization rate in the United States.
Despite a Class I indication, use of concomitant ablation in patients with non-paroxysmal atrial fibrillation undergoing coronary artery bypass grafting is low. Its use may be limited by concerns of the impact on operative outcomes. Using a large national database, we found that surgical ablation did not adversely affect in-hospital mortality or one-year readmissions.
ABSTRACT

Objective: We determined the utilization rate of surgical ablation (SA) during coronary artery bypass grafting (CABG) and compared outcomes between CABG with or without SA in a national cohort.

Methods: The January 2016–December 2018 Nationwide Readmissions Database was searched for all patients undergoing isolated CABG with preoperative persistent or chronic AF by using the ICD-10 classification. Propensity score matching and multivariate logistic regressions were performed to compare outcomes, and Cox proportional hazards model was used to assess risk factors for 1-year readmission.

Results: Of 18899 CABG patients with non-paroxysmal AF, 78% (n=14776) underwent CABG alone and 22% (n=4123) underwent CABG with SA. In the propensity-matched cohort (n=8116), CABG with SA (n=4054; CABG alone, n=4112) was not associated with increased in-hospital mortality (3.4% [139/4112] vs 3.9% [159/4054]; P=.4), index-hospitalization length of stay (10 days vs. 10 days; P=.3), 30-day readmission (19.1% [693/3362] vs. 17.2% [609/3537]; P=.2), or 90-day readmission (28.9% [840/2911] vs. 26.2% [752/2875]; P=.1). Index-hospitalization costs were significantly higher for those undergoing SA ($52,556 vs. $47,433; P<.001). Rates of readmission at 300 days were similar between patients receiving SA (43.8%) and no SA (42.8%; log-rank P=.3). The three most common causes of readmission were not different between groups and included heart failure (24.3% [594/2444]; P=.6), infection (16.8% [411/2444]; P=.5), and arrhythmia (11.7% [286/2444]; P=.2).

Conclusion: In patients with non-paroxysmal AF, utilization of SA during CABG remains low. SA during CABG did not adversely impact mortality or short-term readmissions. These findings support increased use of SA during CABG.
Keywords

coronary artery bypass grafting; atrial fibrillation; surgical ablation; readmissions; Nationwide Readmissions Database
INTRODUCTION

Atrial fibrillation (AF) is the most common adult arrhythmia worldwide and is associated with increased rates of stroke, heart failure, and mortality.\textsuperscript{1–4} Over the past two decades, numerous studies have demonstrated that patients with AF undergoing cardiac surgery have decreased long-term survival if the AF is not treated.\textsuperscript{1,5,6} Progression to chronic or persistent AF is more common with non-paroxysmal AF than with paroxysmal AF and is associated with increased adverse events, including heart failure hospitalization and systemic embolization.\textsuperscript{7–9} Surgical ablation (SA) is a safe and effective treatment modality for patients undergoing cardiac surgery, as it restores normal sinus rhythm and improves quality of life.\textsuperscript{2,10} Furthermore, SA is preferred for those with non-paroxysmal AF because it is associated with long-term maintenance of normal sinus rhythm.\textsuperscript{11,12} Concomitant SA is recommended for patients with AF who are undergoing coronary artery bypass grafting (CABG) with a Class I recommendation.\textsuperscript{13} However, adoption of SA may be limited due to concerns of the impact on operative outcomes, especially in closed atrial operations.\textsuperscript{14}

Although several studies have demonstrated the benefit of SA in patients with AF undergoing CABG, the national utilization rate of SA in patients with non-paroxysmal AF undergoing CABG is currently unknown.\textsuperscript{5,15} Additionally, the impact of SA on hospital readmissions up to one year postoperatively has not been assessed in an all-payer cohort. The aims of the present study were to (1) determine the utilization rate of concomitant SA and (2) compare short-term outcomes in patients with non-paroxysmal AF undergoing CABG with or without SA in a large national cohort.

METHODS
**Data Source**

The Nationwide Readmissions Database (NRD) is the largest publicly available all-payer database of hospital readmissions in the United States.\(^1\)

The NRD uses a complex survey design with clustering and post-stratification that enables national estimates of outcomes using survey-based statistics. Due to its ability to provide reliable linkage between different admissions, the NRD is an optimal data source for assessing readmissions. The NRD contains deidentified demographic, clinical, cost-related, and hospital-specific information on more than 35 million discharges annually. The survey-based design was accounted for in all aspects of the study, and survey-adjusted variances were used to calculate statistics. This methodology has been validated and used extensively in the literature.\(^2\)

Because patient and hospital information contained in the NRD is deidentified to comply with Health Insurance Portability and Accountability Act guidelines, this study was classified as exempt, and Institutional Review Board approval was waived by the Baylor College of Medicine. Informed written consent for the publication of the study data was not required.

**Study Cohort**

We searched the NRD from January 2016 to December 2018 for patients with non-paroxysmal AF undergoing CABG by using the *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) diagnosis codes I48.1, I48.2. Patients undergoing CABG were identified using ICD-10 procedure codes 0201, 0211, 0212, and 0213. Table S1 includes all inclusion and exclusion ICD-10-CM codes. We then stratified patients by those who underwent concomitant SA (ICD-10-CM procedure code: 02560ZZ, destruction of right atrium, open approach; 02570ZZ, destruction of left atrium, open approach; 02580ZZ, destruction of...
conduction mechanism, open approach) and those who underwent isolated CABG without SA.

All admissions, classified as elective or nonelective, were included. Additionally, in-hospital deaths were excluded from calculations other than inpatient mortality, as previously described.\textsuperscript{18,19} A sensitivity analysis of only patients who were on preoperative oral anticoagulation was performed.

**Patient and Hospital Characteristics**

We extracted patient characteristics from the database, including age, sex, payer, and median household income quartile. Comorbidity burden was assessed with the Elixhauser comorbidity index as defined by the Agency for Healthcare Research and Quality using the \textit{comorbidity} R package.\textsuperscript{20} Elective admission was examined as an admission characteristic. Hospital characteristics were teaching status, bed size (small, medium, or large), and urban location as defined by the NRD.

**Index Hospitalization and Readmission Event Outcomes**

The outcomes assessed in this study include index-hospitalization mortality, length of stay (LOS), cost, and 30-day, 90-day, and calendar-year readmission. Causes for readmission were determined by the principal cause of readmission listed for each diagnosis (ICD-10-CM codes) and were grouped into clinically relevant categories as previously described.\textsuperscript{19} In-hospital mortality and LOS were evaluated for each discharge record. Hospital cost was calculated from total charges using the cost-to-charge ratio, a method established via the Health Care Cost and Utilization Project.\textsuperscript{17}
A Kaplan-Meier analysis was performed to assess freedom from readmission over a calendar year. All discharges were assumed to occur on the last day of the month, and patients whose index procedure occurred in December were excluded because the NRD solely reports discharge month. The significance between curves was assessed via a survey-adjusted log-rank test.

Propensity score matching was performed to minimize the impact of confounding factors such as age, sex, elective status, and comorbidities (per the comorbidity R package) on CABG readmission comparisons, as previously described. Propensity scores were evaluated using documented concomitant SA as a dependent variable in a survey-adjusted binomial logistic regression. Cohorts were matched using one-to-one nearest neighbor propensity score matching without replacement and a 0.05 caliper [MatchIt (version 4.2) R package]. A graphical propensity overlay, standardized mean differences, and statistical differences between comorbidities were used to confirm match balance. Acceptable matching was determined via the absolute standardized mean difference of less than .05 (Figure S1).

Multivariable logistic regressions were used to determine risk factors associated with SA. With the use of AUC-guided regression variable selection among variables significant between cohorts and/or present in greater than 5% of the cohorts, 80% of the patients served as a training set, while the remaining 20% was used as independent data for model validation. Additionally, a
Cox proportional hazard model was generated to identify the adjusted risk of readmission over a calendar year.

**Statistical Analysis**

We used R version 4.1 for all statistical analyses. To account for the sampling design of the NRD, we accounted for survey clustering and stratification by using the ‘survey’ package in R. Outcomes of patients undergoing concomitant ablation and isolated CABG were assessed by using chi-square tests with the Rao and Scott adjustment for survey-based data for categorical variables. Continuous variables that were non-normally distributed were compared by using Kruskal-Wallis analysis of variance. The results were presented as the frequency and percentage or as median values with the interquartile range, as appropriate. Less than 1% of values were missing in any category in our cohort; missing values were handled by replacing continuous values with the median of that variable for the overall cohort and replacing categorical values with the mode of that variable for the overall cohort. The matched nature of the data was accounted for in the post-propensity score-matched analysis.

**RESULTS**

**Preoperative Characteristics**

Between January 2016 and December 2018, 18,899 patients with non-paroxysmal AF underwent CABG: isolated CABG in 78.2% (n=14,776) and CABG with concomitant SA in 21.8% (n=4,123; Figure 1). Patients undergoing CABG with SA were younger (median age, 71 vs. 73 years;  \( P < .001 \); Table 1) and more likely to undergo an elective operation (56.9% vs. 50.3%;  \( P < .001 \)). Patients in the SA cohort had higher rates of valve disease (41.0% vs. 31.5%);
P<.001) and long-term anticoagulation use (66.4% vs. 63.7%, P=.04; Table 1), but lower rates of peripheral artery disease (15.1% vs. 20.9%; P<.001), chronic obstructive pulmonary disease (24.4% vs. 27.1%; P=.022), and renal disease (28.0% vs. 33.1%; P<.001). Hospital characteristics were similar between the groups (Table 2). In the propensity-matched cohort (n=8,116), 4,054 patients underwent CABG with SA, and 4,112 underwent isolated CABG. Rates of permanent pacemaker implantation were higher in patients undergoing isolated CABG in the unmatched cohorts (1335/14776, 9.0%, CABG-alone vs. 271/4123, 6.6%, CABG-SA; P=.001), but were not different after propensity-score matching (333/4054, 8.2%, CABG-alone vs. 271/4112, 6.6%; P=.067). However, we were unable to confirm if implantation was done pre- or postoperatively. Patient characteristics and comorbidities were not different between the matched groups (Table 1). In assessing patients on preoperative oral anticoagulation, patient characteristics and comorbidities were not different between matched groups (Tables S2-3).

Index Hospitalization Outcomes

In the propensity-matched cohort, patients undergoing CABG alone or CABG with SA had similar rates of in-hospital mortality (3.9%, CABG-alone vs. 3.4%, CABG-SA; P=.4; Table 3) and index-hospitalization LOS (10 days vs. 10 days; P=.3). Index-hospitalization costs were significantly higher for those undergoing SA ($47,433, CABG-alone vs. $52,556, CABG-SA; P<.001). Rates of left atrial appendage closure were higher in patients undergoing SA (5.4%, CABG-alone vs. 10.7%, CABG-SA; P<.001). Outcomes were similar between groups in our analysis of patients who were on oral anticoagulation (Table S4).

Predictors of Surgical Ablation
On multivariate regression analysis, patients with preoperative congestive heart failure (OR 1.16, 95% CI 1.02-1.32; \(P=.022\)) and those treated in a rural hospital (OR 1.32, 95% CI 1.07-1.62; \(P=.009\)) were more likely to undergo CABG with SA (Figure 2). Patients older than 65 years (OR 0.79, 95% CI 0.66-0.94; \(P=.007\)), those undergoing non-elective operations (OR 0.80, 95% CI 0.71-0.91; \(P<.001\)), and those with preoperative peripheral vascular disease (OR 0.75, 95% CI 0.64-0.88; \(P<.001\)) or renal disease (OR 0.87, 95% CI 0.75-0.99; \(P=.04\)) were less likely to undergo concomitant SA. Low-income patients, defined as those in the lowest income quartile, appeared to be less likely to receive SA (OR 0.87, 95% CI 0.75-1.002; \(P=.053\)); however, this trend did not reach statistical significance.

**Readmission Rates at 30 and 90 Days**

In the propensity-matched cohort, patients undergoing CABG with SA had similar rates of 30-day (17.2%, CABG-alone vs. 19.1%, CABG-SA; \(P=.2\)) and 90-day readmissions (26.2%, CABG-alone vs. 28.9%, CABG-SA; \(P=.1\); Table 3) compared to patients undergoing isolated CABG. Patients receiving SA had significantly higher rates of mortality during readmission (0.5%, CABG-alone vs. 1.2%, CABG-SA; \(P=.008\)) than patients who did not receive SA.

**Readmission Up to One Year**

Rates of readmission at 300 days were similar between patients receiving SA (43.8%) and no SA (42.8%; log-rank \(P=.3\); Figure 3). The three most common causes of readmission were similar between groups and included heart failure (24.3% [594/2444]; \(P=.6\)), infection (16.8% [411/2444]; \(P=.5\)), and arrhythmia (11.7% [286/2444]; \(P=.2\); Figure 4). Other predictors of readmission up to one year on the Cox proportional hazards model included renal disease...
(aHR 1.38, 95% CI 1.28-1.49; \( P < .001 \)), chronic pulmonary disease (aHR 1.33, 95% CI 1.21-1.45; \( P < .001 \)), female sex (aHR 1.25, 95% CI 1.14-1.38; \( P < .001 \)), congestive heart failure (aHR 1.21, 95% CI 1.11-1.31; \( P < .001 \)), diabetes mellitus (aHR 1.18, 95% CI 1.08-1.28; \( P < .001 \)), peripheral vascular disease (aHR 1.13, 95% CI 1.03-1.23; \( P = .007 \)), pulmonary circulatory disorder (aHR 1.11, 95% CI 1.01-1.23; \( P = .038 \)), and non-elective surgery (aHR 1.09, 95% CI 1.03-1.20; \( P = .009 \)).

**DISCUSSION**

This study utilized propensity score matching and multivariable analysis with a large, all-payer database to assess the impact of concomitant SA on outcomes and one-year readmissions in patients with non-paroxysmal AF undergoing CABG. Using this large, all-payer database, we found that the utilization of SA during CABG remains low despite a class I recommendation. In our propensity score-matched analysis, SA during CABG did not affect in-hospital mortality, LOS, readmissions up to one year postoperatively, or causes of readmission but was associated with increased index-hospitalization costs. Interestingly, there was a trend of decreased SA utilization in low-income patients. These findings further support that concomitant SA is safe at the time of CABG.

There is robust evidence that survival is decreased in patients with AF who undergo cardiac surgery if AF is left untreated.\(^1\)\(^5\)\(^6\) Our cohort mortality of 4% was higher compared to an all-comers isolated CABG cohort because our study group included only patients with preexisting AF. The presence of AF in patients undergoing CABG also substantially reduces long-term survival, with up to 24% greater 10-year mortality compared to those without AF.\(^2\)^\(^3\)

Moreover, a systematic review and meta-analysis of 13 studies and over 300,000 patients
demonstrated that those with preexisting AF are at 64% higher risk of early mortality after CABG.\textsuperscript{24} Even when including only propensity-matched studies, preoperative AF was independently associated with a 56% higher risk of perioperative mortality.\textsuperscript{24} Given these data, the Society of Thoracic Surgeons (STS) issued a class I recommendation for concomitant SA during isolated CABG in 2017.\textsuperscript{13} Despite this recommendation, we found that national utilization of SA during CABG remained low during our study period, with less than one-quarter of patients receiving SA for non-paroxysmal AF. Using the STS Adult Cardiac Surgery Database (ACSD), Badhwar and colleagues found that from 2011 to 2014, patients undergoing CABG underwent concomitant SA 33% of the time, the lowest rate of any operation assessed.\textsuperscript{2} Our more recent cohort, which includes procedures performed outside of the STS ACSD, appears significantly lower. This discrepancy may represent nationwide practice variations in SA utilization. Emerging technologies that simplify and potentially reduce the time required to perform SA, such as the EnCompass device from AtriCure, may increase adoption of SA in patients undergoing CABG.\textsuperscript{25} The concern for a potentially increased risk of morbidity during CABG, where a left atriotomy is not otherwise indicated, has been cited as a potential explanation for the low use of concomitant SA.\textsuperscript{14} In our propensity score-matched analysis of more than 8,000 patients, however, SA during CABG did not affect perioperative or short-term outcomes, including in-hospital mortality, index hospitalization LOS, discharge disposition, or readmission up to one year. Rates of in-hospital mortality after CABG with SA have been mixed in previously published literature. In a large analysis of Medicare beneficiaries, Malaisrie et al. demonstrated a 27% greater odds of in-hospital mortality in CABG with SA than CABG alone.\textsuperscript{5} However, this finding contrasts with an analysis from Badhwar and colleagues that found a lower in-hospital
mortality rate in patients undergoing CABG with SA compared to those undergoing CABG with no SA. In our more contemporary, all-payer analysis that includes procedures not accounted for by the STS ACSD, in-hospital mortality was not different between propensity score-matched groups. Although an assessment of long-term mortality was not the purpose of this analysis, a significant mortality benefit for patients undergoing SA with CABG has been previously demonstrated.5,26

Index hospitalization LOS was similar between groups in our study, with both groups admitted a median of 10 days. This conflicts with findings from a single-center study by Ad et al., which demonstrated an increased LOS in patients undergoing a Cox Maze III procedure during CABG or aortic valve replacement (median, 6 days in SA vs. 5 days in no SA)14; however, our results closely align with a national study of patients undergoing CABG with or without concomitant SA (median LOS, 9 days).26 This difference may be due to the slightly less recent cohort in the single-center study, which assessed patients from 2005 to 2012, or to the fact that patients receiving aortic valve replacement and CABG plus aortic valve replacement were included. Finally, because of the intrinsic nature of the NRD, our hospital LOS includes both the preoperative and postoperative period; therefore, the actual postoperative LOS may have shown a similar difference to that of the findings of other investigators.

We found that concomitant SA during CABG was associated with increased index-hospitalization costs compared to CABG alone. This is somewhat unsurprising, as the added initial costs of SA have been demonstrated to be over $4,000 Canadian dollars,27 and the initial costs of catheter ablation have been shown to be as high as $26,656.28 Our study, which found a $5,123 U.S. dollar cost increase, aligns closely with the cost of SA revealed previously. Rankin et al. demonstrated increased in-hospital costs in patients receiving SA during CABG but found
that total inpatient costs were not different between groups after two years.\textsuperscript{26} Thus, an increased upfront cost appears to be balanced by lower resource utilization after surgery.

In our study, rates of readmission at 30 days, 90 days, and one year postoperatively were similar for patients undergoing CABG with SA and CABG alone. These findings support previously published results. Rankin et al. found similar one and two-year readmission rates in patients undergoing CABG with or without SA.\textsuperscript{26} Additionally, Ad et al. found similar 30-day readmission rates in SA versus no SA groups.\textsuperscript{14} We also found that the most common reasons for readmission up to one year, which included heart failure, infection, and arrhythmia, were similar between the study groups. Notably, operative complications such as bleeding or pericardial or pleural effusions were not more common in patients undergoing CABG with SA. It is possible that if NRD readmission outcomes were available for up to two years, differences in readmission may have been seen.

As the use of SA in patients with non-paroxysmal AF undergoing CABG was low, we assessed predictors of receiving concomitant SA in our cohort. We found that patients with preoperative congestive heart failure and those treated in a rural hospital were more likely to undergo SA. Patients older than 65 years, those undergoing non-elective surgery, and those with preoperative peripheral vascular disease or renal disease were less likely to undergo SA. Interestingly, low-income patients appeared to be less likely to receive SA, but this trend did not reach statistical significance. Studies assessing predictors of SA are limited, but Brancato et al. found that patients were less likely to receive SA if they had previous cardiac surgery or if the primary surgeon was further out from training.\textsuperscript{29} Our finding that patients treated in rural hospitals were more likely to undergo SA at the time of CABG is somewhat surprising. We hypothesize that a large proportion of rural hospitals performing cardiac surgery are large
academic centers that may be more likely to perform SA in general. Furthermore, rural hospitals may have fewer administrative restrictions and greater surgeon autonomy. However, both explanations are difficult to support with the NRD and require further study for confirmation.

Our results point to opportunities to increase the adoption of SA during CABG, such as performing SA in patients over 65 and in those with renal or peripheral vascular disease, as these groups are likely to benefit from this procedure. Because CABG accounts for more than half of all cardiac surgeries performed in the United States,\textsuperscript{30} concomitant SA represents a potential avenue for reducing AF-related morbidity and mortality.

Study Limitations

This study has a few important limitations, primarily due to the retrospective analysis of an administrative database such as the NRD. First, using ICD-10 coding, we were not able to determine the extent (e.g., Cox Maze procedure versus pulmonary vein isolation), location (e.g., left atrial versus bi-atrial), or technique (e.g., cryoablation versus radiofrequency ablation versus cut-and-sew) of the SA; we could ascertain only that it was performed using an open approach during CABG. It was also not possible to discern the anatomical or echocardiographic features of each patient, including the size of the atria, which may have influenced the decision to perform SA. In addition, we were unable to assess other surgical details pertinent to the discussion of SA, including operative time or duration of cardiopulmonary bypass. Second, we could not reliably discern if the SA procedure was successful, as we could not assess the rate of postoperative patients who remained in normal sinus rhythm. However, the purpose of our study was not to assess the efficacy of SA, which has been demonstrated previously, but to assess the short-term safety, which has been cited as a potential concern affecting the use of SA during
Third, it is possible that rates of SA and outcomes are different for paroxysmal AF compared to non-paroxysmal AF. Thus, conclusions drawn for one form of AF may be different for another type of AF. In addition, we did not have information on anticoagulation (frequency of use, vitamin K antagonist vs. direct oral anticoagulant), which may have influenced results. Fourth, although we used the primary diagnosis for the cause of readmission, some patients are readmitted for multiple diagnoses. Specifically, we were not able to assess whether the cause of readmission was related to a patient’s procedure or to ascertain if a patient had multiple readmissions. Additionally, because stays in observation units are not technically coded as admissions, these were not captured by the NRD. Finally, because the NRD does not track out-of-hospital deaths, we were unable to perform a competing risks analysis for death versus readmission. Together, these limitations hindered our ability to assess many of the clinical details involved in a nuanced decision to perform SA during CABG. Despite these inherent limitations, however, the larger sample size and all-payer nature that databases such as the NRD can provide may produce more generalizable results, and the survey-adjusted statistics implemented in this study take into account the estimated variance from the assumptions used in the NRD’s design.

CONCLUSION

In patients with non-paroxysmal AF, utilization of SA during CABG remains low. Surgical ablation during CABG did not affect mortality, short-term readmissions, or causes of readmission but was associated with increased index-hospitalization costs (Figure 5), although specific details on the type of SA are necessary to draw more firm conclusions. Older patients and those with renal or peripheral vascular disease were less likely to receive SA. These findings
further support the safety of concomitant surgical AF ablation at the time of CABG and identify opportunities to increase the use of SA during CABG.

Acknowledgments

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REFERENCES


FIGURE LEGENDS

FIGURE 1. Flow diagram detailing the application of inclusion and exclusion criteria and the final cohort for analysis. AF, Atrial fibrillation; CABG, coronary artery bypass grafting.

FIGURE 2. Forest plot depicting predictors of receiving surgical ablation during coronary artery bypass grafting. SA, Surgical ablation.

FIGURE 3. Kaplan-Meier estimates of readmission of patients with non-paroxysmal atrial fibrillation undergoing coronary artery bypass grafting with or without surgical ablation. Freedom from readmission within one year was similar between groups (P = .3, long-rank test). Shaded areas represent 95% confidence intervals.

FIGURE 4. Clinical reasons for one-year readmission for non-paroxysmal atrial fibrillation patients with or without concomitant surgical ablation.

FIGURE 5. Impact of surgical ablation of non-paroxysmal atrial fibrillation during coronary artery bypass grafting on mortality and readmissions. From 2016 to 2018, 18899 patients with non-paroxysmal atrial fibrillation underwent coronary artery bypass grafting. A total of 4123 (21.8%) underwent concomitant surgical ablation and 14776 (78.2%) underwent isolated CABG. After propensity score matching, surgical ablation was not associated with increased length of stay, in-hospital mortality, or readmissions up to one year. AF, atrial fibrillation; CABG, coronary artery bypass grafting.
TABLE 1. Characteristics and comorbidities of patients with chronic or persistent atrial fibrillation undergoing CABG with and without concomitant surgical ablation

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Pre-propensity score matched</th>
<th>Propensity score matched</th>
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<tr>
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<td>CABG-SA (N = 4,123)</td>
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<td>71 (66-76)</td>
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<td>Age breakdown, n (%)</td>
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<td>Income quartile, n (%)</td>
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<td>Elixhauser score, median (IQR)</td>
<td>18 (9-28)</td>
<td>17 (9-27)</td>
</tr>
<tr>
<td>Congestive heart failure, n (%)</td>
<td>8,684 (58.8)</td>
<td>2,494 (60.5)</td>
</tr>
<tr>
<td>Arrhythmia, n (%)</td>
<td>14,776 (100.0)</td>
<td>4,123 (100.0)</td>
</tr>
<tr>
<td>Valve disease, n (%)</td>
<td>4,652 (31.5)</td>
<td>1,692 (41.0)</td>
</tr>
<tr>
<td>Condition</td>
<td>Sample 1</td>
<td>Sample 2</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>Long-term anticoagulation use</td>
<td>9,410 (63.7%)</td>
<td>2,736 (66.4%)</td>
</tr>
<tr>
<td>Pulmonary circulation disorder</td>
<td>2,088 (14.1%)</td>
<td>634 (15.4%)</td>
</tr>
<tr>
<td>Peripheral artery disease</td>
<td>3,092 (20.9%)</td>
<td>623 (15.1%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>13,507 (91.4%)</td>
<td>3,712 (90.0%)</td>
</tr>
<tr>
<td>COPD</td>
<td>4,009 (27.1%)</td>
<td>1,005 (24.4%)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>7,279 (49.3%)</td>
<td>1,947 (47.2%)</td>
</tr>
<tr>
<td>Renal disease</td>
<td>4,884 (33.1%)</td>
<td>1,154 (28.0%)</td>
</tr>
<tr>
<td>Liver disease</td>
<td>751 (5.1%)</td>
<td>160 (3.9%)</td>
</tr>
<tr>
<td>Coagulopathy</td>
<td>3,876 (26.2%)</td>
<td>1,267 (30.7%)</td>
</tr>
<tr>
<td>Alcohol abuse</td>
<td>587 (4.0%)</td>
<td>238 (5.8%)</td>
</tr>
<tr>
<td>Drug abuse</td>
<td>186 (1.3%)</td>
<td>65 (1.6%)</td>
</tr>
<tr>
<td>Depression</td>
<td>1,250 (8.5%)</td>
<td>333 (8.1%)</td>
</tr>
</tbody>
</table>

*Kruskal-Wallis rank-sum test for complex survey samples; chi-squared test with Rao & Scott's second-order correction.
**TABLE 2.** Hospital characteristics of patients with chronic or persistent atrial fibrillation undergoing CABG with and without concomitant surgical ablation

<table>
<thead>
<tr>
<th>Comorbidity</th>
<th>Pre-propensity score matched</th>
<th>Propensity score matched</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CABG-only (N = 14,776)</td>
<td>CABG-SA (N = 4,123)</td>
</tr>
<tr>
<td>Bed size, n (%)</td>
<td>P value*</td>
<td>P value*</td>
</tr>
<tr>
<td>Large</td>
<td>9,828 (66.5)</td>
<td>2,691 (65.3)</td>
</tr>
<tr>
<td>Medium</td>
<td>3,583 (24.3)</td>
<td>1,007 (24.4)</td>
</tr>
<tr>
<td>Small</td>
<td>1,365 (9.2)</td>
<td>424 (10.3)</td>
</tr>
<tr>
<td>Teaching, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metro non-teaching</td>
<td>2,539 (17.2)</td>
<td>668 (16.2)</td>
</tr>
<tr>
<td>Metro teaching</td>
<td>11,732 (79.4)</td>
<td>3,344 (81.1)</td>
</tr>
<tr>
<td>Non-metro</td>
<td>505 (3.4)</td>
<td>110 (2.7)</td>
</tr>
<tr>
<td>City size, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large metropolitan</td>
<td>7,605 (51.5)</td>
<td>2,135 (51.8)</td>
</tr>
<tr>
<td>Micropolitan</td>
<td>461 (3.1)</td>
<td>110 (2.7)</td>
</tr>
<tr>
<td>Non-urban residual</td>
<td>44 (0.3)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Small metropolitan</td>
<td>6,666 (45.1)</td>
<td>1,878 (45.5)</td>
</tr>
</tbody>
</table>

*Kruskal-Wallis rank-sum test for complex survey samples; chi-squared test with Rao & Scott's second-order correction.*
TABLE 3. Outcomes of patients with chronic or persistent atrial fibrillation undergoing CABG with and without concomitant surgical ablation

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Pre-propensity score matched</th>
<th></th>
<th></th>
<th>Propensity score matched</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CABG-only N = 12,839</td>
<td>CABG-SA N = 3,643</td>
<td>$P$ value*</td>
<td>CABG-only N = 3,537</td>
<td>CABG-SA N = 3,632</td>
<td>$P$ value*</td>
</tr>
<tr>
<td>In-hospital mortality, n/N (%)</td>
<td>636/14,776 (4.3)</td>
<td>139/4,123 (3.4)</td>
<td>.1</td>
<td>159/4,054 (3.9)</td>
<td>139/4,112 (3.4)</td>
<td>.4</td>
</tr>
<tr>
<td>LOS (days), median (IQR)</td>
<td>10 (7-16)</td>
<td>10 (7-16)</td>
<td>.2</td>
<td>10 (7-15)</td>
<td>10 (7-16)</td>
<td>.3</td>
</tr>
<tr>
<td>Cost ($), median (IQR)</td>
<td>48,044 (35,650-67,652)</td>
<td>52,628 (40,310-71,870)</td>
<td>&lt;.001</td>
<td>47,433 (35,572-67,878)</td>
<td>52,556 (40,296-71,843)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Left atrial appendage occlusion, n (%)</td>
<td>743 (5.0)</td>
<td>440 (10.7)</td>
<td>&lt;.001</td>
<td>221 (5.4)</td>
<td>440 (10.7)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Disposition, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home healthcare</td>
<td>5,147 (40.1)</td>
<td>1,441 (39.5)</td>
<td></td>
<td>1,451 (41.0)</td>
<td>1,438 (39.6)</td>
<td></td>
</tr>
<tr>
<td>Routine</td>
<td>3,257 (25.4)</td>
<td>1,035 (28.4)</td>
<td></td>
<td>960 (27.1)</td>
<td>1,030 (28.4)</td>
<td></td>
</tr>
<tr>
<td>SNF or ICF</td>
<td>4,294 (33.4)</td>
<td>1,136 (31.2)</td>
<td></td>
<td>1,092 (30.9)</td>
<td>1,133 (31.2)</td>
<td></td>
</tr>
<tr>
<td>30-day readmissions, n (%)</td>
<td>2,370 (18.5)</td>
<td>695 (19.1)</td>
<td>.6</td>
<td>609 (17.2)</td>
<td>693 (19.1)</td>
<td>.2</td>
</tr>
<tr>
<td>90-day readmissions, n/N (%)</td>
<td>2,961/10,463 (28.3)</td>
<td>841/2,920 (28.8)</td>
<td>.7</td>
<td>752/2,875 (26.2)</td>
<td>840/2,911 (28.9)</td>
<td>.1</td>
</tr>
<tr>
<td>Died on readmission, n/N (%)</td>
<td>173/14,776 (1.2)</td>
<td>51/4,123 (1.2)</td>
<td>.8</td>
<td>20/4,054 (0.5)</td>
<td>51/4,112 (1.2)</td>
<td>.008</td>
</tr>
<tr>
<td>Readmission LOS (days), median (IQR)</td>
<td>4 (2-7)</td>
<td>4 (2-8)</td>
<td>.2</td>
<td>4 (2-7)</td>
<td>4 (2-8)</td>
<td>.3</td>
</tr>
<tr>
<td>Readmission cost ($), median (IQR)</td>
<td>9,280 (5,221, 18,092)</td>
<td>9,664 (5,514, 18,463)</td>
<td>.3</td>
<td>9,360 (5,147, 17,382)</td>
<td>9,665 (5,510, 18,542)</td>
<td>.3</td>
</tr>
<tr>
<td>Elective readmission, n/N (%)</td>
<td>509/14,776 (3.4)</td>
<td>155/4,123 (3.8)</td>
<td>.5</td>
<td>135/4,054 (3.3)</td>
<td>155/4,112 (3.8)</td>
<td>.5</td>
</tr>
</tbody>
</table>
CABG, coronary artery bypass grafting; ICF, intermediate care facility; IQR, interquartile range; LOS, length of stay; SNF, skilled nursing facility. *Kruskal-Wallis rank-sum test for complex survey samples; chi-squared test with Rao & Scott's second-order correction.
Impact of Concomitant Ablation of Non-Paroxysmal Atrial Fibrillation during Coronary Artery Bypass Grafting on Mortality and Readmissions

2016-2018 Nationwide Readmissions Database

- Use of surgical ablation of atrial fibrillation during CABG remains low.
- Surgical ablation during CABG did not affect length of stay, mortality, or short-term readmissions.
- These findings support increased use of surgical AF ablation during CABG.

AF, atrial fibrillation; CABG, coronary artery bypass grafting
Patients ≥ 18 years old undergoing CABG from 2016 - 2018: N = 523,042

Excluded because of:
- No preoperative AF: n = 340,172
- Paroxysmal AF: n = 81,335
- Unspecified AF: n = 82,636

Patients undergoing CABG with chronic or persistent AF: n = 18,899

No surgical ablation: n = 14,776
Surgical ablation: n = 4,123

Propensity Score Matching (age, electiveness, gender, comorbidities)

No ablation: n = 4,054
Ablation: n = 4,112
Clinical Reasons for 1-Year Readmission

- Hypertension or heart failure
- Confirmed or suspected infection
- Conduction disorder
- Pericardial or pleural effusion
- Non-infectious respiratory disease
- Gastrointestinal bleeding
- Ischemic heart disease
- Cerebrovascular disease
- Renal failure

Ablation
No Ablation
Impact of Concomitant Ablation on Non-Paroxysmal Atrial Fibrillation during Coronary Artery Bypass Grafting on Mortality and Readmissions

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Michael E. DeBakey Department of Surgery, Baylor College of Medicine