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Postoperative Atrial Fibrillation and Mortality After Coronary Artery Bypass Surgery

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OBJECTIVES We sought to determine if the occurrence of postoperative atrial fibrillation (AF) affects early or late mortality following coronary artery bypass surgery (CABG).

BACKGROUND Atrial fibrillation is the most common arrhythmia seen following CABG.

METHODS The Texas Heart Institute Cardiovascular Research Database was used to identify all patients that developed AF after isolated initial CABG from January 1993 to December 1999 (n = 994). This population was compared with patients who underwent CABG during the same period but did not develop AF (n = 5,481). In-hospital end points were adjusted using logistic regression models to account for baseline differences. Long-term survival was evaluated using a retrospective cohort design, where Cox proportional hazards methods were used to adjust for baseline differences, and with case-matched populations (n = 390, 195 per arm).

RESULTS Atrial fibrillation was diagnosed in 16% of the population. Postoperative AF was associated with greater in-hospital mortality (odds ratio [OR] 1.7, $p = 0.0001$), more strokes (OR 2.02, $p = 0.001$), prolonged hospital stays (14 vs. 10 days, $p < 0.0001$), and a reduced incidence of myocardial infarction (OR 0.62, $p = 0.01$). At four to five years, survival was worse in patients who developed postoperative AF (74% vs. 87%, $p < 0.0001$ in the retrospective cohort; 80% vs. 93%, $p = 0.003$ in the case-matched population). On multivariate analysis, postoperative AF was an independent predictor of long-term mortality (adjusted OR 1.5, $p < 0.001$ in the retrospective cohort; OR 3.4, $p = 0.0018$ in the case-matched population).

CONCLUSIONS The occurrence of AF following CABG identifies a subset of patients who have a reduced survival probability following CABG. The impact of various strategies, such as antiarrhythmics and warfarin, aimed at reducing AF and its complications deserves further study. (J Am Coll Cardiol 2004;43:742–8) © 2004 by the American College of Cardiology Foundation

Atrial fibrillation (AF) is the most common rhythm disturbance following coronary artery bypass surgery (CABG) (1). With continuous electrocardiographic monitoring, reported postoperative AF incidences range from 25% to 40% post-CABG and up to 62% after a combined CABG and valve procedure (1–3). The occurrence of postoperative AF has been associated with prolonged length of stay (LOS), intensive care unit readmission, a greater need for reintubation, persistent congestive heart failure (CHF), stroke, and increased overall costs (4–8). Although studies abound examining the predictors of AF, cost impact, LOS, and the effects of various prophylactic interventions aimed at reducing the incidence of AF and LOS, none have systematically reviewed the impact of postoperative AF upon prognosis for survival. This study was undertaken to determine the impact of postoperative AF on in-hospital and late outcomes, addressing specifically the issue of mortality.

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METHODS

Study population. RETROSPECTIVE COHORT. The Texas Heart Institute (THI) Cardiovascular Research database was used to identify all patients who developed any AF as a postoperative complication following their first isolated revascularization procedure from January 1993 to December 1999 (AF, n = 994). Those who did not develop postoperative AF during the same period served as the control population (no-AF, n = 5,481). Patients were excluded if they had preexisting AF of any type, thyroid disease, or concomitant vascular or valve surgery. The study was limited to residents of Texas.

CASE-MATCHED SUBSTUDY. The case-match study population was derived by matching the AF and no-AF populations derived from the retrospective cohort for as many variables as possible, with emphasis on matching predictors of mortality and postoperative complications associated with early mortal-

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Abbreviations and Acronyms

AF = atrial fibrillation
CABG = coronary artery bypass graft surgery
CAD = coronary artery disease
CHF = congestive heart failure
CI = confidence intervals
COPD = chronic obstructive pulmonary disease
CPK = creatine phosphokinase
CVD = cerebrovascular disease
IMA = internal mammary artery
LOS = length of stay
MI = myocardial infarction
OR = odds ratio
PVD = peripheral vascular disease
THI = Texas Heart Institute
TIA = transient ischemic attack

ity. This was done to reduce the impact of early mortality and highlight longer term differences.

Study design and end points. The study design is depicted in Figure 1. The two populations were compared for the in-hospital end points of early death (≤30 days), myocardial infarction (MI), stroke, and LOS using a retrospective cohort design. Logistic regression analysis was utilized to statistically adjust for differences in baseline differences and confounding variables. Long-term mortality was then evaluated simultaneously using two parallel methods: a retrospective cohort design, where Cox proportional hazards methods were used to adjust for differences in baseline characteristics and comorbidities, and case-matching methods. Follow-up was obtained using the THI Cardiovascular Research database in conjunction with the state's vital statistics system.

Definitions. *Postoperative AF* was defined by the documentation of AF of any duration at any time in the postoperative period on a physician assessment, on the basis of a rhythm strip or 12-lead electrocardiogram recording. *Variables defined by patient history* were hypertension, angina severity, congestive heart failure (CHF), family history of CAD, previous MI, renal insufficiency, diabetes mellitus, peripheral vascular disease (PVD), transient ischemic attack (TIA), cerebrovascular disease (CVD), abdominal aortic aneurysm, and chronic obstructive pulmonary disease (COPD). Patient history was obtained by interview at hospital or clinic presentation and entered prospectively into the database. *Angina* was defined by the Canadian Cardiovascular Society Classification and *CHF* by the New York Heart Association criteria. *Postoperative MI* was defined by the elevation of creatine phosphokinase (CPK) and CPK-MB ≥3× the upper limits of normal, or by new Q waves on follow-up electrocardiograms.

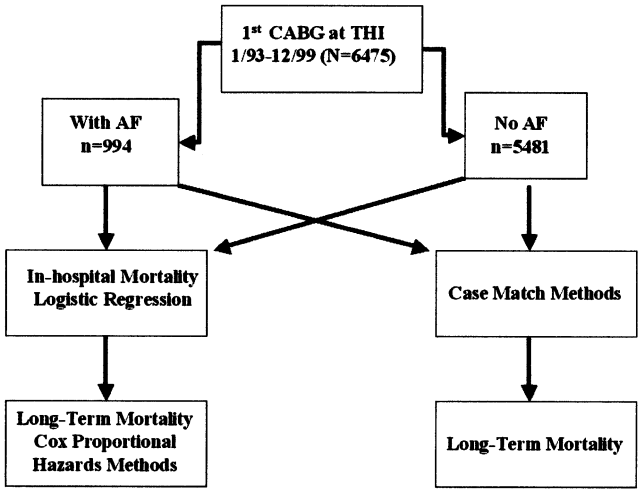

Figure 1. Study design. AF = atrial fibrillation; CABG = coronary artery bypass graft surgery; THI = Texas Heart Institute.

Statistical analysis. Baseline characteristics are presented as mean values with standard deviation or as percentage of total patients with available data in each group. Pearson's chi-square test for discrete variables and Student *t* test continuous variables were used for comparisons. The SAS Vax/VMS Version 6.09 (SAS Institute, North Carolina) was used for analysis. A value of $p < 0.05$ was considered significant.

Logistic regression and Cox proportional hazard models utilizing a forward stepwise variable selection process were developed to determine which clinical and angiographic variables were associated with early and late mortality, respectively. After stepwise models were developed for predicting mortality using patient risk factors, the presence or absence of AF (AF or no-AF, coded as 1 and 0, respectively) was then added to the models to determine if survival was dependent on the presence or absence of AF while controlling for significant patient risk factors. The exponential of the coefficient of this variable is the hazard ratio for AF:no-AF. This hazard (or odds) ratio is the ratio of mortality of the AF to no-AF population at any given point in time, controlling for differences in patient covariates or risk factors.

In comparing the long-term survival of each of the patient subgroups, a different model was used for each group using Cox proportional hazards models that retain only the significant predictors of survival. The 95% confidence intervals (CIs) for the hazard ratios were calculated to test for significant differences in survival between AF and no-AF. Logarithms of the ratios and their CIs were then computed so that intervals on either side of 1 would have values that were comparable.

To measure survival differences in percentages rather than in relative terms for each patient subgroup, a Cox proportional hazards model for the subgroup was used to construct adjusted Kaplan-Meier survival curves for the AF and the no-AF patients. The adjusted survivals were calculated from the Cox models fixing the coefficients for the other covariates at their means and varying the coefficient for the procedure. The resulting two curves were plotted for each subgroup for comparison.

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Table 1. Retrospective Cohort: Clinical Characteristics

	AF (%) n = 994	No-AF (%) n = 5,481	p Value
Mean age (yrs)	67.9 ± 9.6	62.2 ± 10.7	< 0.0001
Female	26.7	26.1	0.7
Hypertension	71.4	67.7	0.02
Smoker	55.2	53.9	0.44
Hypercholesterolemia	46.8	50.4	0.04
Unstable angina	62.6	62.5	0.96
NYHA functional class 3 to 4	85.4	86.6	0.33
Congestive heart failure	15.6	12.3	0.005
Mean EF (%)	48.9 ± 14	49.4 ± 13	0.36
Prior myocardial infarction	17.4	15.4	0.12
Cerebrovascular disease	7.8	5.6	0.006
Prior TIA	4.98	3.02	0.0016
Peripheral vascular disease	27.9	17.5	< 0.0001
COPD	28.2	22.2	< 0.0001
Diabetes	10.8	11	0.84
Renal insufficiency	10.5	9.6	0.38
Number of vessels			0.013
1-vessel	9	12	
2-vessel	28	28	
3-vessel	60	56	
Obesity	15.9	19.9	0.004
Use of IABP	5.8	3.7	0.0018

AF = atrial fibrillation; COPD = chronic obstructive pulmonary disease; EF = ejection fraction; IABP = intraaortic balloon pump; NYHA = New York Heart Association; TIA = transient ischemic attack.

RESULTS

Retrospective cohort study. Between January 1, 1993, and December 31, 1999, a total of 6,477 patients who were Texas residents underwent their isolated first CABG at the THI. Of these, 994 patients (16%) developed AF during their postoperative course. The mean follow-up was 4 ± 2 years. Follow-up was 100%.

Baseline patient characteristics are presented in Table 1. Patients who developed AF were older, more often hypertensive, had COPD, non-coronary vascular disease, CHF, and more severe underlying CAD. They were also more likely to have had an IABP placed and longer cardiopulmonary bypass times. Conversely, they were less likely to be obese or hypercholesterolemic. There was no difference in the prevalence of diabetes mellitus or prior MI. Multivariate predictors for the occurrence of postoperative AF were age >65 years (odds ratio [OR] 2.4, 95% CI 2.06 to 2.74, p < 0.0001), COPD (OR 1.26, 95% CI 1.08 to 1.47, p = 0.004), PVD (OR 1.54, 95% CI 1.31 to 1.81, p < 0.0001), and preprocedure use of an IABP (OR 1.71, 95% CI 1.26 to 2.32, p = 0.0005).

In-hospital outcomes are presented in Figure 2. Patients with postoperative AF had significantly greater incidences of stroke and early death. The LOS was longer for patients with AF, but the MI rate was less. While in hospital, patients who developed AF were more likely to have an infection, CHF, respiratory failure, renal failure, shock, multiorgan system failure, or a cardiac arrest. At discharge, they were more likely to be sent home on anticoagulants and/or antiarrhythmic therapy (Table 2).

Long-term mortality was significantly poorer for patients who developed postoperative AF. Actuarial (observed) survival at one and four years were 87% versus 94% and 74% versus 87% (adjusted OR 1.5 over the time period, 95% CI 1.26 to 1.77, p < 0.0001), for the AF and no-AF populations, respectively. These differences persisted after excluding early mortality (adjusted OR 1.4 over the time period, 95% CI 1.12 to 1.68, p = 0.002). Multivariate predictors of

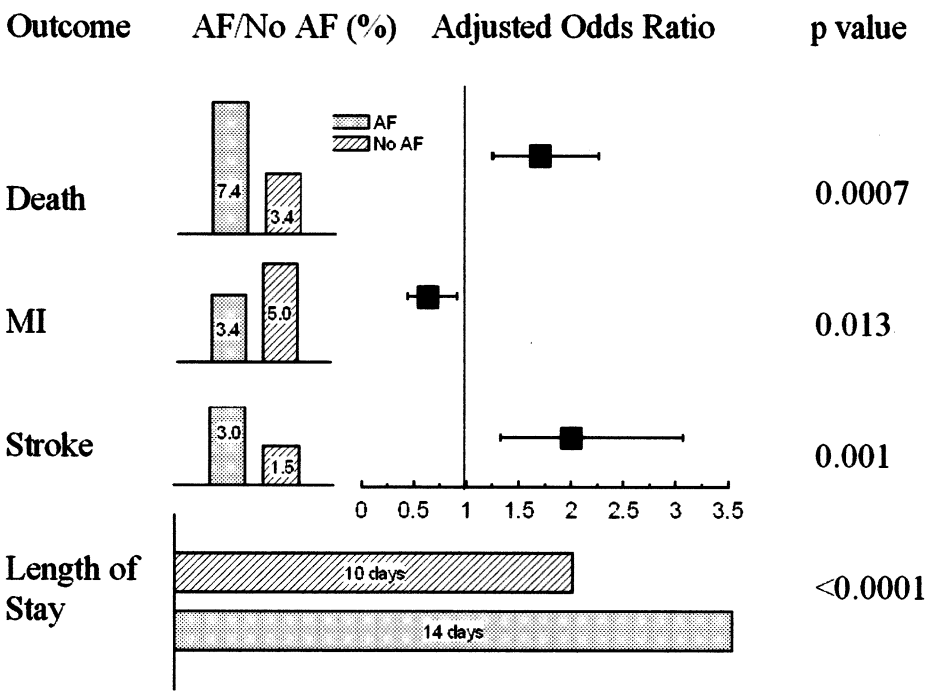

Figure 2. Actuarial and risk-adjusted in-hospital outcomes. AF = atrial fibrillation; MI = myocardial infarction.

Table 2. Retrospective Cohort: In-Hospital Outcomes/Variables

	AF (%) n = 994	No-AF (%) n = 5,481	p Value
Complications			
Myocardial infarction	4.4	7.4	< 0.0001
Stroke	5.2	1.7	< 0.0001
Any infection	17.2	5.9	< 0.0001
Respiratory failure	28.5	12.5	< 0.0001
CHF	2.4	1.1	0.0016
Hypotension requiring pressors	17.2	6.1	< 0.0001
Renal failure	12.1	4.7	< 0.0001
Shock	2.5	1.02	0.0001
Multisystem failure	0.79	0.33	0.03
CP arrest	2.4	0.8	< 0.0001
Discharge on anticoagulants	14	6.25	< 0.0001
Discharge on any antiarrhythmics	31.4	7.3	< 0.0001

AF = atrial fibrillation; CP = cardiopulmonary; CHF = congestive heart failure.

long-term mortality are presented in Table 3. Figures 3A and 3B show the adjusted survival curves for the retrospective cohort, with and without the influence of early mortality. Both curves demonstrate a continual divergence.

Mortality in the case-matched population. A total of 390 patients (195 per arm) were identified. Clinical characteristics of patients selected for the case-matched study are depicted in Table 4. To reduce the impact of early mortality and the possibility that postoperative AF was a marker of a terminal in-hospital illness, the matching algorithm was designed to match for the presence or absence of postoperative complications associated with early mortality (Table 4). The populations compared were reasonably well matched. Table 5 demonstrates equivalent in-hospital outcomes in the case-matched population and supports the adequacy of the matching process.

Table 3. Retrospective Cohort: Multivariate Predictors of Long-Term Mortality

	Adjusted OR	95% CI	p Value
Postoperative AF	1.5	1.26–1.77	< 0.0001
Use of IMA	0.76	0.64–0.89	0.0008
CHF	1.71	1.46–2.01	< 0.0001
NYHA functional class 3 to 4	1.56	1.21–2.03	0.0007
PVD	1.33	1.14–1.55	0.0003
Number of vessels diseased	1.13	1.03–1.24	0.0079
Urgent procedure	1.38	1.16–1.64	0.0002
Pre-IABP	1.42	1.11–1.83	0.0059
Diabetes	1.37	1.15–1.64	0.0038
Age >65 yrs	2.04	1.76–2.37	< 0.0001
Renal insufficiency	1.67	1.39–1.99	< 0.0001
Prior TIA	1.55	1.19–2.03	0.0013
CVD	1.43	1.15–1.78	0.0014
Postoperative			
Stroke	1.62	1.24–2.12	0.0005
MI	1.34	1.06–1.69	0.0125
Hypotension requiring pressors	2.77	2.03–3.79	< 0.0001
Renal failure	1.78	1.48–2.14	< 0.0001
Discharge medications			
Beta-blocker	0.63	0.54–0.72	< 0.0001
ASA	0.53	0.47–0.61	< 0.0001
Hypolipidemic	0.74	0.59–0.91	0.0055

AF = atrial fibrillation; ASA = aspirin; CHF = congestive heart failure; CI = confidence interval; CVD = cerebrovascular disease; IMA = internal mammary artery; MI = myocardial infarction; NYHA = New York Heart Association; OR = odds ratio; Pre-IABP = preprocedure use of an intraaortic balloon pump; PVD = peripheral vascular disease; TIA = transient ischemic attack.

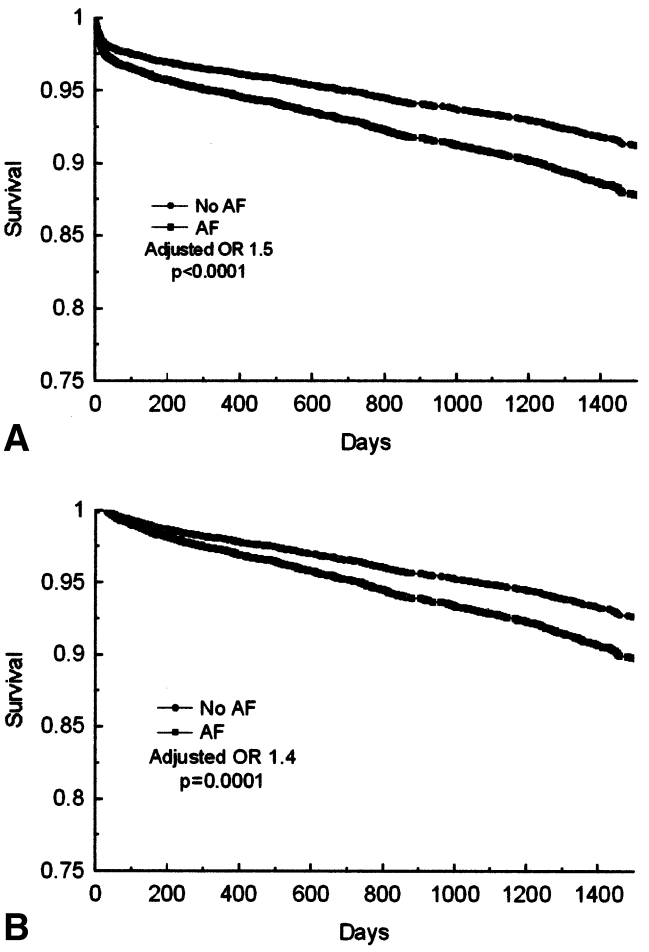

Figure 3. Risk-adjusted survival in all patients **(A)** including early (<30 days) mortality and **(B)** excluding early mortality. Note the continual divergence of both curves. AF = atrial fibrillation; OR = odds ratio.

The mean follow-up was 5 ± 2 years. Actuarial survival at one, three, and five years were 96% versus 98%, 86% vs. 94%, and 80% vs. 93% (OR 3.4 over the time period, 95% CI 1.58 to 7.45, p = 0.0018), for the AF and no-AF populations, respectively. Figure 4 shows the survival curves for the case-matched population. Consistent with the findings in the retrospective cohort, these curves are diverging and suggestive of an ongoing risk associated with postoperative AF.

Subset analysis. Multivariate predictors of late mortality in the patients who developed postoperative AF and in those who did not are depicted in Table 6. Use of an IMA graft and discharge on a beta-blocker or aspirin conferred similar protective effects on both populations. Discharge on any antiarrhythmic agent was associated with a 32% reduction in

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Table 4. Case-Matched: Clinical Characteristics and In-Hospital Outcomes/Variables

Variable	AF (%) n = 195	No-AF (%) n = 195
Mean age (yrs)	66 ± 8	65 ± 9
Female	17.7	17.7
Hypertension	67.6	68.7
Smoker	54.7	55.1
Hypercholesterolemia	50.6	50.6
Unstable angina	64.5	65.3
NYHA functional class 3 to 4	91.3	91.3
Mean EF (%)	51 ± 12	50 ± 12
Prior myocardial infarction	9.4	9.4
Cerebrovascular disease	1.1	1.1
Prior TIA	0	0
Peripheral vascular disease	12.4	12.4
COPD	22.6	16.6
Diabetes	3.4	3.4
Renal insufficiency	7.2	6.4
Number of vessels		
1-vessel	9.1	9.1
2-vessel	31.3	31.3
3-vessel	59.6	59.6
Use of an IMA graft	90.6	90.2
Postoperative complications		
Myocardial infarction	1.5	1.5
Stroke	0	0
Any infection	1.9	1.9
Respiratory failure	5.7	5.7
CHF	0	0
Hypotension requiring pressors	0	0
Renal failure	0	0
Multisystem failure	0	0

All p values >0.05.
EF = ejection fraction; other abbreviations as in Tables 2 and 3.

all-cause mortality (OR 0.68, p = 0.0106) only in patients with postoperative AF, whereas discharge on warfarin exerted a neutral effect in both populations. Hypolipidemic therapy improved whereas diabetes negatively affected the survival of the no-AF patients, but did not appear to influence outcomes in patients with postoperative AF. Variables of CHF, poor functional class, and severity of coronary and noncoronary vascular disease were associated with increased mortality in both populations.

DISCUSSION

Although the morbidity of postoperative AF is well documented, it has not been clearly established whether postoperative AF is associated with excess mortality. In earlier studies, the occurrence of postoperative AF did not appear

Table 5. Case-Matched: In-Hospital Outcomes

Outcome	AF (n = 195)	No-AF (n = 195)	p Value
Death	1.0	0	0.16
MI	1.5	2.1	0.7
Stroke	0	0	1.0
Hospital stay	9.98	9.13	0.24

Abbreviations as in Table 3.

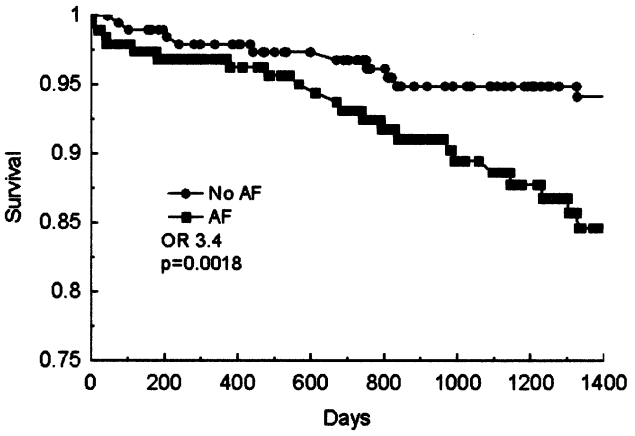

Figure 4. Survival in the case-matched population. Abbreviations as in Figure 3.

to impact upon short and long-term outcomes (9–11). The tachyarrhythmia itself was short-lived with more than 90% of patients reverting to sinus rhythm at six to eight weeks following surgery (11). In a study of 123 patients with postoperative AF identified by continuous electrocardiographic monitoring, Rubin et al. found no difference in the outcomes of angina, stroke, death, or MI while in hospital and at an average of 26 weeks of follow-up (10).

In more recent studies, postoperative AF has been associated with a two- to fourfold increased risk of stroke at 30 days, a 4- to 5-day increase in hospital LOS, and an increase in the cost of care on the order of approximately $10,000 per patient (5,6,8,12–17). To our knowledge, only four studies have described an association between postoperative AF and mortality, two of which were in non-CABG populations (4,18–20). Krowka et al. (18) and von Knorring et al. (19) reported early mortality rates of 22% and 17%, respectively, in patients who developed postoperative tachyarrhythmias after undergoing pneumonectomy for a primary pulmonary pathology. Stamou et al. (20) described significantly greater in-hospital mortality (3% vs. 1%) in a population of 206 patients who developed AF following minimally invasive CABG. In the only study that has looked beyond early outcomes, Almassi et al. (4) described both an increase in early (5.95% vs. 2.95%) and late mortality (9.4% vs. 4.2%). Follow-up, however, was only for six months.

Our study is consistent with the literature in that we report similar predictors for the development of AF, an increased incidence of stroke, and a prolongation of hospital stay. But more importantly, our study provides strong evidence that postoperative AF is associated with an increased early and late mortality risk. This association persists after adjustment for known confounding variables such as MI, CHF, prior stroke, TIA, CVD, PVD, COPD, diabetes, and advanced age. Although most of the death associated with AF occurred early in the postoperative period, the association with late mortality remained statistically significant after exclusion of early mortality and was further strengthened by consistent findings in a simultaneous case-matched population. Furthermore, Kaplan-

Table 6. Multivariate Predictors of Mortality for AF and No AF Populations

Variable	Adjusted OR	95% CI	p Value
AF population			
Use of IMA	0.691	0.52–0.92	0.0117
CHF	1.48	1.12–2.97	0.0067
NYHA class 3 to 4	1.73	1.08–2.8	0.024
PVD	1.48	1.14–1.93	0.003
No. of vessels diseased	1.14	1.04–1.24	0.0044
Postoperative			
Respiratory failure	1.47	1.09–1.99	0.0123
Hypotension	1.59	1.18–2.14	0.0026
CP arrest	1.89	1.11–3.21	0.019
Renal failure	1.96	1.4–2.7	< 0.0001
Discharge medications			
Beta-blocker	0.6	0.445–0.81	0.0008
ASA	0.56	0.43–0.74	< 0.0001
Antiarrhythmic	0.68	0.513–0.916	0.0106
No-AF population			
Use of IMA	0.722	0.61–0.85	0.0002
CHF	1.79	1.52–2.12	< 0.0001
NYHA class 3 to 4	1.31	1.02–1.69	0.0381
PVD	1.36	1.16–1.59	0.0002
No. of vessels diseased	1.13	1.04–1.24	0.006
Diabetes	1.4	1.17–2.02	0.0002
Renal insufficiency	1.61	1.34–1.94	< 0.0001
Prior TIA	1.5	1.123–2.01	0.0061
CVD	1.58	1.26–1.98	< 0.0001
Postoperative			
MI	1.54	1.17–2.02	0.0019
Stroke	1.98	1.42–2.76	< 0.0001
Hypotension	1.48	1.18–1.85	0.0007
CP arrest	1.7	1.03–2.83	0.0395
Renal failure	1.98	1.6–2.45	< 0.0001
Shock	3.58	2.43–5.29	< 0.0001
Discharge medications			
Beta-blocker	0.62	0.53–0.73	< 0.0001
ASA	0.53	0.46–0.62	< 0.0001
Hypolipidemic	0.7	0.55–0.88	0.0025

Abbreviations as in Tables 2 and 3.

Meier survival curves in both study populations with a mean of four and up to six years of follow-up were diverging, suggesting that clinical recognition of this once thought temporary or isolated event identifies an ongoing or persistent effect.

The mechanisms by which postoperative AF is associated with mortality are speculative. In the short term, hemodynamic compromise and CHF directly as a result of the loss of atrial transport function may certainly contribute. In the long term, mechanistic and causal links are more difficult to establish. Possibilities include the development of CHF with its attendant mortality risk, the occurrence of disabling stroke or other embolic catastrophes, and adverse drug effects, such as proarrhythmia with antiarrhythmic drugs or hemorrhage with anticoagulants. Unfortunately, it is currently unknown whether patients who have postoperative AF also tend to develop left ventricular dysfunction, chronic or persistent AF, an increased long-term stroke risk, or even require additional pharmacotherapeutics. Although Loubani et al. (21) reported a 50% persistence of AF at discharge and 39% at six months, these data were obtained from a small number of patients (83 patients with postoperative AF). This dearth of knowledge is confounded by the fact that the mode and immediate cause of death in this particular population is also unknown.

An important paradigm that must be considered is that it is not postoperative AF per se that causes an increased mortality, but rather postoperative AF is a marker for other conditions with a propensity for mortality, such as CHF, left ventricular dysfunction, advanced age, and other comorbidities. Stated differently, patients with AF are just sicker. Patients who developed AF were older and with more comorbidities. Although this statement is appealing, our study shows that the converse is true. Using statistical methods identical to those used in the Framingham study and other large population-based studies that have delineated risk factors for disease processes, we have shown that postoperative AF is independently associated with a reduced survival. This predictive power of AF persists even after statistical adjustment for confounding variables and comorbid conditions. In order to exclude the possibility that postoperative AF may occur in association with preterminal events and is thus not causally related, comparisons were performed censoring in-hospital mortality. The association between postoperative AF and reduced survival remained and the ongoing effect was highlighted by continual divergence of survival curves. Furthermore, the case-control comparison that reduces the effect of comorbidities upon subsequent differences in survival produced consistent results.

Our data also show a reduction in the incidence of postoperative MI and suggest improved survival in patients discharged on antiarrhythmic therapy. The possible reasons for a reduced incidence of postoperative MI, which differs from that reported in the literature, include an increased likelihood of receiving beta-blockade and anticoagulation and antiplatelet therapy, as well as the possibility of random error. On subset analysis, the findings of improved survival with use of an IMA, aspirin, or beta-blockers, and reduced survival with CHF, poor functional class, and more severe vascular disease are consistent with the literature. However, the most intriguing finding on subset analysis is the survival benefit in patients discharged on any antiarrhythmic therapy. In the THI cardiovascular research database, antiarrhythmic therapy is coded if patients are discharged on any of the class I or III agents by the Vaughan-Williams classification. Although a 32% relative risk reduction in mortality is noteworthy and suggests benefit with these agents, this finding must be viewed with caution. This was obtained in a retrospective nonrandomized population. The exact identity of the antiarrhythmic agent used is unknown, nor can it be ascertained whether the antiarrhythmic was prescribed for the postoperative AF. Nonetheless, this exciting observation suggests that perhaps some therapy is available that may improve outcomes in postoperative AF patients.

This study is limited by its retrospective nature and the fact that it comes from a single center. Although our query was designed to include all cases of postoperative AF, the

prevalence of postoperative AF was 16%, which is significantly lower than other reports. This low prevalence may be attributed to, at least in part, the exclusion of patients with valvular disease and those with prior AF. However, we must acknowledge the possibility that AF may have been underreported and only severe, persistent cases of postoperative AF were included, thereby biasing the data to exaggerate the mortality difference. Our data do not permit us differentiate between early- or late-occurring AF or ascertain the duration of AF, factors likely to have prognostic significance. Moreover, we have insufficient data to make meaningful conclusions on the impact of antiarrhythmics or anticoagulants on mortality. The effects of treatment on outcomes are difficult to delineate in a longitudinal observational study because sicker patients are more likely to be treated. Furthermore, we do not have data on the immediate cause of death. Because of limited resources, we were only able to track deaths in Texas residents. Autopsy data were not available and the cause of death listed in the field was not believed to be sufficiently accurate to identify cardiac death. Thus, all-cause mortality was used. As such, the mechanisms of postoperative AF-associated mortality remain at best speculative. Finally, the limitations of the methodology must also be acknowledged. Although we have attempted to adjust for a plethora of variables, we acknowledge that unmeasured factors can influence outcomes. In defense of the method, studies that have utilized large observational databases have yielded information that were consistent with, and at times predicted, the results of randomized trials. Although our data did not permit us to address the questions of post-discharge management, long-term or recurrent stroke, AF, rehospitalization, freedom from symptoms or repeat revascularization, the follow-up data for our sole end point, death, is irrefutable. In spite of these limitations, our investigation supports the contention that postoperative AF is associated with excess mortality, which persists after adjustment for coexisting comorbid conditions.

CONCLUSIONS

Postoperative AF is associated with an increased hospital stay, an increased early stroke risk, and reduced in-hospital and long-term survival. This association is independent of coexisting cardiovascular disease and comorbidities. The mechanisms underlying this excess mortality are unknown. The impact of various therapies aimed at reducing postoperative AF and its complications needs further investigation.

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