Development and Outcomes Assessment of an Evidence-Based Treatment Algorithm for Post-Operative Atrial Fibrillation

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Abstract

Background: Practice guidelines exist for treatment of post-operative atrial fibrillation (PAOF); however, no accepted algorithm exists to guide treatment.

Objective: To determine if patients treated according to an investigator-compiled practice algorithm based on the American College of Cardiology (ACC)/American Heart Association (AHA)/European Society of Cardiology (ESC) guidelines have better outcomes when compared to patients whose treatment does not follow this algorithm.

Methods: A retrospective, descriptive, pilot study was conducted on a convenient sample all cardiac surgery patients from 2011 to 2013 at an urban, Midwestern Medical center (N = 140). Subjects whose treatment followed the investigator-compiled algorithm and associated outcomes were compared to those whose treatment did not.

Results: Twenty-six (34.67%) of 75 subjects who met the inclusion criteria were treated according to the investigator-compiled algorithm. The majority of subjects were Caucasian males who underwent coronary artery bypass graft (CABG). Patients who were treated according to the algorithm were found to have a 3.08 times greater odds of conversion into normal sinus rhythm than those whose treatment deterred from the algorithm ($p = 0.1979$). A significant difference was detected in time spent in the intensive care unit (ICU) between groups ($p = 0.0451$). No other significant differences in outcomes were detected.

Conclusions: Few patients were treated according to the algorithm, suggesting that extensive education is needed in order to translate ACC/AHA/ESC guidelines into practice. This algorithm has the potential to facilitate treatment which is in agreement with evidence-based best practices, reduce ICU costs, and improve conversion rates.

Keywords: Atrial Fibrillation; Postoperative Complications; Thoracic Surgery; Clinical Protocols

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Introduction

Atrial fibrillation is a dysrhythmia that originates above the ventricles and is characterized by chaotic atrial electrical activity and consequent uncoordinated atrial contraction (Wann et al., 2011). Post-operative atrial fibrillation (POAF), a type of atrial fibrillation noted as the most common complication following coronary artery bypass graft (CABG) and valvular surgery, has been reported as occurring in up to 57% of this patient population (Beaulieu et al., 2010; Halonen et al., 2010; Jakubováa et al., 2012; Sanoski, 2010).

Background/Significance

POAF is associated with significant morbidity and mortality, increased inpatient length of stay (LOS), increased overall health care costs, and serious complications such as stroke and heart failure (Wann et al., 2011). Bramer et al. (2010) determined that new onset POAF following CABG surgery was an independent predictor of mortality (n = 1,122). At an end point of five years postoperatively, a significant difference in overall mortality was found between patients with POAF (15%) compared to those without (10%) ($p < 0.0001$). Helgadottir et al. (2012) reported an increase in LOS from two to five days ($p < 0.001$) which translates into increased health care costs. Speir et al. (2009) also found a statistically significant increase in cost associated with POAF in post-operative CABG patients (n = 14,780) by 10.3% or $2,744 ($p < 0.001$). Secondary complications of POAF are documented to include: death, stroke, cognitive dysfunction, impaired left ventricular function, hemodynamic instability, decreased exercise tolerance, and decreased quality of life (Camm et al., 2010). Gutierrez and Blanchard (2011), estimate the risk of stroke to be approximately 5% per year if anticoagulation was not achieved.

Materials and Methods

In 2006, the American College of Cardiology (ACC), the American Heart Association (AHA), and the European Society of Cardiology (ESC) collaborated and developed evidence-based practice guidelines for POAF treatment. Updated guidelines were released in 2011 with additional considerations and recommendations provided. Because several acceptable treatments for POAF exist, proper management of this dysrhythmia can be unclear to providers who are ordering treatment. Additionally, despite these practice guidelines being well supported, patients are not being treated according to them. In order to determine if outcome variances exist based on treatment provided, a clear and systematic POAF treatment algorithm was developed for use in this study delineating the ACC/AHA/ESC recommendations. Therefore, the purpose of this study was to determine if patients who received treatment that followed the investigator-compiled algorithm had superior outcomes (i.e. conversion rate, placement at discharge, hospital LOS, and time spent in the intensive care unit [ICU]) when compared to patients whose treatment did not follow the algorithm.

A retrospective, descriptive, non-experimental design pilot study was conducted on a sample of men and women having undergone CABG, valve, or combined CABG/valve surgery from 2011-2013 (N = 140), at an urban, Midwestern medical center. This time period was selected as it coincided with adoption of the 2011 updated guidelines. Inclusion criteria for this study was: 1) having undergone CABG surgery, valve surgery, or combined CABG/valve surgery via a sternotomy approach, 2) being a patient in the cardiovascular surgical ICU, and 3) experiencing POAF with a rapid ventricular response (HR > 100). Persons were excluded if they had a previous history of atrial fibrillation, and/or if they experienced spontaneous conversion

into sinus rhythm not requiring intervention. Eligible patients (n = 75), were identified with the assistance of an outcomes specialist.

No power analysis was performed due to this study being the first to evaluate ACC/AHA/ESC guideline adherence. This study was approved by the university's institutional review board, as well as by the research committee of the facility where data was collected.

Statistical Analysis

All statistical analysis was completed with the assistance of a statistician using SAS software version 9.3. Frequency summaries were described for each variable collected. Demographic data which was collected include: age, gender, and ethnicity. Other variables of interest which were collected include: surgical type, use of cardiopulmonary bypass, presence of obesity (BMI > 30), presence of sleep apnea, presence of other co-morbidities, day of POAF development, time till treatment, type of treatment received, and whether or not the algorithm was followed. Outcome variables which were collected include: whether or not conversion occurred, presence of complications related to POAF, length of time in POAF, length of ICU stay, length of overall hospital stay, and placement at discharge. The SAS/FREQ procedure was used to evaluate the relationship between the algorithm being followed and the rate of conversion from POAF to normal sinus rhythm. The SAS/FREQ procedure was also used to evaluate the relationship between the algorithm being followed and discharge placement. Fisher's exact test was used to test for significance. The SAS/GLIMMIX procedure was used to compare mean lengths of stay between patients who were treated according to the algorithm, and those whose treatment deterred from the algorithm. The type III test of fixed effects was used to test for significance. Welch's two sample t-test and Wilcoxon's sum rank test were used to compare

means for dependent variables including: time to treatment, time in POAF, and ICU hours between patients treated according to the algorithm versus those who were not.

Results

Frequency summaries for data variables collected are displayed in the Demographic and Patient Characteristics Table (Table 1). The majority of subjects were male, less than 85 years of age, Caucasian, underwent CABG surgery without the use of cardiopulmonary bypass, and had a history of hypertension. POAF occurred most frequently between post-operative day (POD) 0-4, and was treated most often with Diltiazem.

Only 26 (34.7%) of the subjects were treated according to the investigator-compiled algorithm. Patients who were treated according to the algorithm; however, were estimated to have a 3.08 times greater odds of conversion into normal sinus rhythm than those who treatment deterred from the algorithm ($p = 0.1979$). When including death as a possible discharge placement, there was no association between whether or not the algorithm was followed and placement at discharge ($p = 1.00$). The overall mean lengths of hospital stay were 9.38 and 8.12 days for patients whose treatment was compliant with the algorithm versus those whose was not, respectively. The difference between these two means was not statistically significant ($p = 0.3680$). However, a statistically significant decrease was detected in mean time spent in the ICU (419.62 minutes vs. 575.92 minutes) between patients treated according to the algorithm and those who were not ($p = 0.0451$). In regards to outcomes, no other statistically significant differences were detected between groups.

Discussion

Discussion is limited due to the unique nature of this pilot study, as well as the small sample size; however, it is important to note that patients who developed POAF and were treated

according to the algorithm were 3.08 times more likely to convert into normal sinus rhythm prior to discharge. If this study had been fully powered, statistical significance would have likely been found. Additionally, approximately 156 fewer hours were spent in the ICU for patients treated according to the algorithm.

The majority of subjects in this study were men under 86 years of age which is supported by the AHA (2012) report that the incidence of atrial fibrillation increases with age. The incidence is approximately 21 per 100,000 for men age 15 to 44 and increases to 1,077 per 100,000 for those over 85 years of age. Similar increases were also reported with women but the incidence for women over 85 years old surpassed that of men (1,204 per 100,000).

The incidence of POAF following cardiac surgery observed in this study varied depending on the type of surgical procedure employed, with 59%, 24%, and 17% of subjects having undergone CABG, valve, and combined CABG/valve, respectively. The literature also reports a varied incidence based on cardiac surgery type (Halonen et al., 2010; Beaulieu at al., 2010; Rho, 2009; Patel et al., 2008).

The literature cites multiple risk factors believed to contribute to the development of POAF, one of which is a history of hypertension (Alqahtani, 2010). This was consistent with this study's findings of 52% of the sample having a documented history of hypertension. .

The use of extracorporeal circulation (ECC), also referred to as cardiopulmonary bypass, observed in this study was almost equal for patients who experienced POAF, with 53% performed "off-pump" and 47% "on-pump." This finding is contrary to what was found by Jakubová et al. (2012) in a study of 1966 cardiac surgery patients in which 75% of "on-pump" patients, and 46% of "off-pump" patients experienced POAF.

The overall mortality observed in this study was 15% observed at an endpoint of hospital discharge. A total of five patient deaths occurred. This is higher than the early mortality observed by Attaran et al. (2011) and lower than the overall long-term mortality observed by Girerd et al. (2011).

There are contradicting reports of which drug is favored for treating POAF. Calcium channel blockers were used to treat 40% of POAF patients in this study which represented the largest percentage of patients treated pharmacologically; however, guidelines put forth by the American College of Chest Physicians (AACP, 2005) recommends calcium channel blockers, especially diltiazem, as a second-line agent when beta-blockers are unavailable or contraindicated. Diltiazem is the preferred agent for those patients who may be too unstable to tolerate beta-blockers.

Amiodarone was used to treat 32% of POAF patients in this study representing the second largest percentage of patients treated pharmacologically. This is in contrast to guidelines put forth by the ACCP (2005) who recommend against the use of amiodarone as a first-line agent. Evidence shows that amiodarone is no more advantageous at rate control than beta-blockers or calcium channel blockers; however, carries a greater risk of significant adverse effects (ACCP, 2005; Camm, Camm, & Savelieva, 2012)

Beta-blockers were used to treat 12% of POAF patients in this study which represented the smallest percentage of patients treated pharmacologically. This challenges the recommended usage outlined in the literature. Algahtani (2010) states that beta-blocking agents are the therapy of choice postoperatively for rate control, whereas Nair (2010) claims that other rate control therapies which do not have beta blocking activity are less effective due to increased adrenergic response. According to Omae and Kanmura (2012) beta-blockers are more effective than any

other agent including calcium channel blockers at slowing AV nodal conduction. Furthermore, beta-blockers have been shown to accelerate the time to conversion when compared to other agents.

Limitations

Limitations of this pilot study include the non-experimental design and the small, convenient, non-randomized sample obtained from a single site. This limits the generalizability of the findings. Since this was a pilot study, and the first of its kind, comparisons with the literature are limited. All study data was obtained via retrospective chart audit, therefore, the accuracy of the charted data is not easily verified. Additionally, treatment and conversion times were based solely on documentation and may not reflect accurate times.

Practice Implications

Extensive provider education is needed in order to translate ACC/AHA/ESC guidelines into treatment regimens. Significant study findings suggest that algorithm utilization may: facilitate appropriate evidence-based POAF treatment, reduce healthcare costs related to length of ICU stay, and limit overall time spent in POAF reducing symptom burden and complications.

Recommendations for Future Research

This algorithm needs to be adopted into clinical use as a protocol to guide postoperative management. Once protocol implementation is complete, a sufficiently powered, prospective, descriptive study is needed to determine its effect on POAF outcomes.

Conclusions

Only 35% of patients who developed POAF following cardiac surgery were treated according to the investigator-compiled algorithm developed to reflect the current ACC/AHA/ESC guidelines. For those patients who received treatment which was in agreement

with these guidelines, conversion rates were higher while hours spent in the ICU were lower than those who were not treated per this algorithm. These findings of this study suggest that the algorithm has the potential to facilitate evidence-based treatment best practices. This may further reduce ICU costs while improving conversion rates.

References

Algahtani, AAR. Atrial fibrillation post cardiac surgery trends toward management. Heart Views. 2010;11(2):57-63. doi: 10.4103/1995-705X.73212

Attaran S, Shaw M, Bond L, Pullan MD, Fabri BM. Atrial fibrillation postcardiac surgery: A common but a morbid complication. Interact Cardiovasc Thorac Surg. 2011; 12(5):772-777. doi: 10.1510/icvts.2010.243782

Beaulieu Y, Denault AY, Couture P, et al. Perioperative intravenous amiodarone does not reduce the burden of atrial fibrillation in patients undergoing cardiac valvular surgery. Anesthesiology. 2010; 112(1):128-137. doi: 10.1097/ALN.0b013e3181c61b28

Bramer S, Van Straten AHM, Hamad MAS, Berreklouw E, Martens EJ, Maessen JG. The impact of new-onset postoperative atrial fibrillation on mortality after coronary artery bypass grafting. Ann Thorac Surg. 2010; 90(2):443-449. doi: 10.1016/j.athoracsur.2010.03.083

Camm AJ, Camm CF, Savelieva I. Medical treatment of atrial fibrillation. J Cardiovasc Med. 2012;13:97-107. doi: 10.2459/JCM.0b013e32834f23e1

Camm AJ, Kirchhof P, Lip GYH, et al. Guidelines for the management of atrial fibrillation. Eur Heart J. 2010; 31:2369-2429. doi: 10.1093/eurheartj/ehq278

Girerd N, Magne J, Pibarot P, Voisine P, Dagenais F, Mathieu P. Postoperative atrial fibrillation predicts long-term survival after aortic-valve surgery but not after mitral-valve surgery: A retrospective study. BMJ. 2011;1(2):e000385. doi:10.1136/bmjopen-2011-000385

Gutierrez C, Blanchard DG. Atrial fibrillation: Diagnosis and treatment. Am Fam Physician. 2011; 83(1):61-68.

Halonen J, Loponen P, Järvinen O, et al. Metoprolol versus amiodarone in the prevention of

atrial fibrillation after cardiac surgery: A randomized trial. Ann Intern Med. 2010; 153(11):703-709. doi:10.7326/0003-4819-153-11-201012070-00003

Helgadottir S, Sigurdsson MI, Ingvarsdottir IL, Arnar DO, Gudbjartsson T. Atrial fibrillation following cardiac surgery: Risk analysis and long-term survival. J Cardiothorac Surg. 2012; 7(1):87. doi:10.1186/1749-8090-7-87

Jakubováa M, Mitrob P, Stanˇcákb B, et al. The occurrence of postoperative atrial fibrillation according to different surgical settings in cardiac surgery patients. Interact Cardiovasc Thorac Surg. 2012; 15:1007-1012. doi:10.1093/icvts/ivs361

Kaireviciute D, Aidietis A, Lip GYH. Atrial fibrillation following cardiac surgery: Clinical features and preventative strategies. Eur Heart J. 2009;30:410-425. doi: 10.1093/eurheartj/ehn609

Martinez EA, Epstein AE, Bass EB. American College of Chest Physicians guidelines for the prevention and management of postoperative atrial fibrillation after cardiac surgery. Chest. 2005;128(2):56S-60S. doi: 10.1378/chest.128.2_suppl.56S

Nair SG. Atrial fibrillation after cardiac surgery. Ann Card Anaesth. 2010;13(3):196-205.

Omae T, Kanmura Y. Management of postoperative atrial fibrillation. J Anesth. 2012;26(3):429-437. doi: 10.1007/s00540-012-1330-9

Patel D, Gillinov MA, Natale A. Atrial fibrillation after cardiac surgery: Where are we now? Indian Pacing Electrophysiol J. 2008;8(4):281-291.

Rho RW. Atrial fibrillation: The management of atrial fibrillation after cardiac surgery. Heart. 2009;95(5):422-429. doi: 10.1136/hrt.2007.132795

Sanoski CA. Prevalence, pathogenesis, and impact of atrial fibrillation. Am J Health Syst Pharm. 2010;67(9):S11-S16. doi: 10.2146/ajhp100148

Speir AM, Kasirajan V, Barnett SD, Fonner E. Additive costs of postoperative complications for isolated coronary artery bypass grafting patients in Virginia. Ann Thorac Surg. 2009;88:40-46. doi:10.1016/j.athoracsur.2009.03.076

Wann LS, Cutis AB, Ellenbogen KA, et al. 2011 ACCF/AHA/HRS focused updates incorporated into the ACC/AHA/ESC 2006 guidelines for the management of patient with atrial fibrillation: A report of the American College of Cardiology Foundation/American Heart Association task force on practice guidelines. Circulation. 2011;123:269-367. doi: 10.1161/CIR.0b013e318214876d

Appendix

Figure 1. Cora POAF Algorithm © 2014 Creighton University

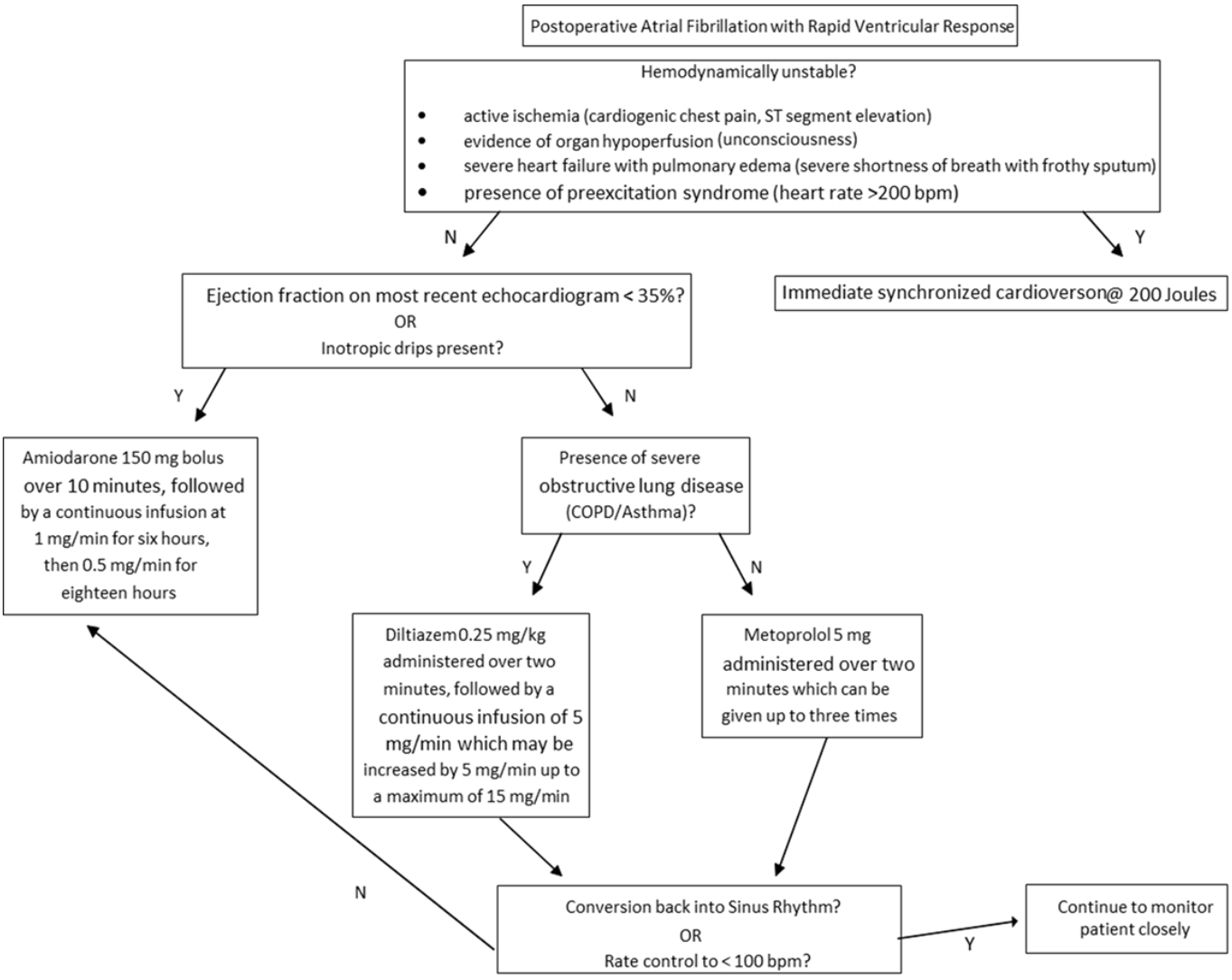

Table 1. Demographic and Patient Characteristics

Factor	Level	Frequency	Percent
Gender	Female	24	32%
	Male	51	68%
Ethnicity	African American	2	3%
	Caucasian	72	96%
	Hispanic	1	1%
Surgery Type	CABG	44	59%
	Valve	18	24%
	CABG + Valve	13	17%
Use of Bypass	No	40	53%
	Yes	35	47%
Obesity	No	39	52%
	Yes	36	48%
Sleep Apnea	No	64	85%
	Yes	11	15%
Co-morbidities	DM	1	1.5%
	HTN	36	52%
	HTN + DM	31	45%
	HTN + DM + CKD	1	1.5%
Day of POAF	POD 0-4	69	92%
	POD 5 +	6	8%
Treatment	Amiodarone	24	32%
	DC Cardioversion	2	3%
	Digoxin	10	13%
	Diltiazem	30	40%
	Metoprolol	9	12%
Conversion	No	12	16%
	Yes	63	84%
Guidelines Followed	No	49	65%
	Yes	26	35%