

POST-OPERATİF ATRİAL FİBRİLASYON HASTALARINA VAKALARLA YAKLAŞIM

Dursun AKASLAN¹

GİRİŞ

Paroksismal atrial fibrilasyon (POAF) kardiyak cerrahi sonrası majör komplikasyonlardan biri olup, yüksek mortalite ve morbidite oranlarına ve uzamış hastane yatas süreleri nedeniyle bakım harcamalarında artışa neden olmaktadır. Sıklıkla post-operatif ilk hafta veya hemen sonrasında gelişmektedir.¹⁻² POAF herhangi bir kardiyak cerrahi sonrası gelişen ritim bozukluğu olarak tanımlanmış olup, akut, paroksismal, persistant veya permanent olarak farklı gruplara sınıflandırılmıştır.

POAF'a bağlı olarak gelişen inme, akut böbrek yetmezliği, kalp yetersizliği ve ölümü de içeren birçok komplikasyon meydana gelebilir³. POAF'ın patogenezi tam olarak bilinmemekle⁴ birlikte temel etyolojik faktörler olarak; inflamatuvar süreç, oksidatif stres, otonomik disfonksiyon ve atriyumun yapısal ve fonksiyonel remodelingi düşünülmektedir⁵. Bu aşamada hastada predispozan faktörlerin önceden bilinmesi korunma ve tedavi açısından son derece önem arz etmektedir. Biz bu derlemede POAF patogenezi, epidemiyolojisi, hazırlayıcı faktörleri ve potansiyel tedavi seçeneklerini ayrıntılı şekilde değerlendirilip, örnek 2 vaka üzerinden de hastalara temel yaklaşım algoritma-mızı açıklamayı hedefledik.

Vaka-1

- 75 yaşında erkek hasta , 3 aydır artan şiddetle eforla ilişkili göğüs ağrısı mevcut hastanın bilinen HT, Tip2 DM, HL tanıları mevcut. Hasta bu şikayet ile başvurduğu kardiyoloji polikliniğinde yapılan tetkikler neticesinde koroner arter hastalığı evaluasyonu için koroner anjiyografi planlandı.
- Fizik muayene: S1-S2 ritmik düzenli üfürüm yok, solunum normal ral yok ronküs yok ,Pre-tibial ödem +/+, Göz çevresinde ksantolezma+ • Aile öyküsü-, Sigara+
- İlaç öyküsü: Asetil salisilik asit 1x1, Perindopril 5 mg tb 1x1, Atorvastatin 10 mg tb 1x1, İnsülin preparatları 3x40 Ü
- Lab: Hemogram paneli normal AKŞ: 220mg/dL LDL: 180 mg/dl Kr: 1,1 GFR%50
- EKG: 84/dk sinüs ritminde hiperetrofiye bağlı strain paterni mevcut ve anterior leadlerde(V1-V4) simetrik T negatifliği
- EKO: EF%45 ,anterior duvar mid ve basal seviyede hipokinetik ,hafif mitral yetersizliği, sinnirda dilate sol atrium alanı(LAa: 19 cm²)
- Miyokard perfüzyon sintigrafisinde anterior duvar tüm seviyelerde orta-ağır iskemi+
- KAG: LMCA: plaklı LAD : proksimal %99 darlık D1 osteal %70 darlık Cx: mid bölge %60 darlık, distal diffüz hastalıklı RCA : plaklı, dominant

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Tablo 2. POAF yönetim algoritması

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|----------------|---|
| Pre-operatif | Predispozan faktörleri kullanarak risk sınıflamasını uygula Hastanın hemodinamik stabilizasyonunu değerlendirir Majör risk faktörlerini kontrol et Beta bloker tedavi başla ve pre-operatif tedaviye ara verme Beta blokerler kontrendike ise KKB başla, selektif gruptarda antiaritmik başlanabilir Serum seviyesine göre Mg tedavisi başla Koruyucu olabilecek ilaçlar: vitaminler, ranolazin ve NAC Yan etkisi olabilecek ilaçlar: statinler(akut böbrek hasarı), kolsisin(GİS intoleransı) Önerilmeyen ilaçlar: PUFA, digoksin, steroidler ve vernekalant |
| İntra-operatif | Volum dengesini optimize et Kardiyopulmoner baypass zamanını minimize et Minimal invaziv teknikleri tercih et İlaç kullanamayan hastalarda posterior perikardiyektomi uygula Atrial pacing önerilmemektedir LAA kapatma işlemi önerilmemektedir |
| Post-operatif | Sıvı-elektrolit dengesini optimize et Mekanik ventilasyon süresini en aza indirmeye çalış Vazopressör ve İnotropik ilaçları en kısa sürede kesmeye çalış Tekrarlayan veya dirençli AF hastalarında medikal tedaviyi gözden geçir Beta bloker ve antiaritmik ajanlara devam et |

SONUÇ

POAF post-operatif kardiyak cerrahisi sonrası sık görülen bir komplikasyon olup yüksek mortalite ve morbiditeye yol açabilmektedir. POAF gelişimindeki ana patofizyolojik mekanizmada şunlar bulunmaktadır; inflamasyon, oksidatif stres, otonomik disfonksiyon ve atriyumun yapısal ve fonksiyonel remodelingi. Bunun yanında majör kardiyovasküler risk faktörlerini de içeren pre-operatif riskler, cerrahi teknik ile ilişkili intra-operatif riskler ve post-operatif risk faktörleri de POAF gelişiminde etkili olabilmektedir. Operasyon öncesi risk faktörlerinin ayrıntılı bir şekilde değerlendirilmesi ve profilaktik tedavilerin başlanılmasının POAF insidansını azaltmadan yapılması gereken en önemli önlemler olduğu düşünülmektedir. Bir çok klavuzda beta blokerler ve amiodaron gibi antiaritmik ilaçların tedaviye eklenilmesi önerilse de yukarıda ayrıntılı bir şekilde açıkladığımız bir çok upstream tedavi mevcuttur. Onlarında rutin tedaviye eklenebilmesinin çok önemli olduğu kanaatindeyiz. Bununla birlikte POAF hastalarında persistan AF gelişen yada POAF gelişen yaşlı hastalarda tromboembolik profilaksi olarak antikoagulan tedavinin başlanması gerekmektedir, ancak DOAK'ların tedaviye eklenilmesi için yeterli kanıt halen bulunmamaktadır.

Bu derlemede anlatılanları özetleyecek şekilde bir algoritma yapıldı (Tablo 2).

REFERANSLAR

- Aranki SF, Shaw DP, Adams DH, Rizzo RJ, Couper GS, Van- derVliet M, et al. Predictors of atrial fibrillation after coronary artery surgery. Current trends and impact on hospital resources. Circulation. 1996;94:390–7.
- Raiten J, Patel PA, Gutsche J, Management of postoperative atrial fibrillation in cardiac surgery patients. 2015. In: Conference management of postoperative atrial fibrillation in cardiac surgery patients, pp. 122–29. SAGE Publications
- Yadava M, Hughey AB, Crawford TC. Postoperative atrial fibrillation: incidence, mechanisms, and clinical correlates. Cardiol Clin. 2014;32:627–36.
- Ferro CR, Oliveira DC, Nunes FP, Piegas LS. Postoperative atrial fibrillation after cardiac surgery. Arq Bras Cardiol. 2009;93:59–63.
- Echahidi N, Pibarot P, O'Hara G, Mathieu P. Mechanisms, prevention, and treatment of atrial fibrillation after cardiac surgery. J Am Coll Cardiol. 2008;51:793–801.
- Mathew JP, Fontes ML, Tudor IC, Ramsay J, Duke P, Mazer CD, et al. A multicenter risk index for atrial fibrillation after cardiac surgery. JAMA. 2004;291:1720–9.
- Lee JK, Klein GJ, Krahn AD, Yee R, Zarnke K, Simpson C, et al. Rate-control versus conversion strategy in postoperative atrial fibrillation: a prospective, randomized pilot study. Am Heart J. 2000;140:871–7.
- Frendl G, Sodickson AC, Chung MK, Waldo AL, Gersh BJ, Tisdale JE, et al. 2014 AATS guidelines for the prevention and management of perioperative atrial fibrillation and flutter for thoracic surgical procedures. J Thoracic Cardiovasc Surg. 2014;148:e153–93.

9. Maesen B, Nijs J, Maessen J, Allessie M, Schotten U. Post-operative atrial fibrillation: a maze of mechanisms. *Europac.* 2012;14:159–74.
10. Zangrillo A, Landoni G, Sparicio D, Benussi S, Aletti G, Pap- palardo F, et al. Predictors of atrial fibrillation after off-pump coronary artery bypass graft surgery. *J Cardiothorac Vasc Anes-* thesis. 2004;18:704–8.
11. Andrews TC, Reimold SC, Berlin JA, Antman EM. Prevention of supraventricular arrhythmias after coronary artery bypass sur- gery. A meta-analysis of randomized control trials. *Circulation.* 1991;84:Iii236–44.
12. Rezaei Y. Anti-inflammatory role of statins in preventing post- operative atrial fibrillation. *Am J Cardiol.* 2016;117:314.
13. Tselentakis EV, Woodford E, Chandy J, Gaudette GR, Saltman AE. Inflammation effects on the electrical properties of atrial tissue and inducibility of postoperative atrial fibrillation. *J Surg Res.* 2006;135:68–75.
14. Abdelhadi RH, Gurm HS, Van Wagoner DR, Chung MK. Rela- tion of an exaggerated rise in white blood cells after coronary bypass or cardiac valve surgery to development of atrial fibrilla- tion postoperatively. *Am J Cardiol.* 2004;93:1176–8.
15. Ucar HI, Tok M, Atalar E, Dogan OF, Oc M, Farsak B, et al. Pre- dictive significance of plasma levels of interleukin-6 and high- sensitivity C-reactive protein in atrial fibrillation after coronary artery bypass surgery. *Heart Surg Forum.* 2007;10:E131–5.
16. Ishida K, Kimura F, Imamaki M, Ishida A, Shimura H, Kohno H, et al. Relation of inflammatory cytokines to atrial fibrillation after off-pump coronary artery bypass grafting. *Eur J Cardio- thoracic Surg.* 2006;29:501–5.
17. Lo B, Fijnheer R, Nierich AP, Bruins P, Kalkman CJ. C-reactive protein is a risk indicator for atrial fibrillati- on after myocardial revascularization. *Ann Thorac Surg.* 2005;79:1530–5.
18. Rezaei Y, Gholami-Fesharaki M, Dehghani MR, Arya A, Haghjoo M, Arjmand N. Statin antiarrhythmic effect on atrial fibrillation in statin-naïve patients undergoing car- diac surgery: a meta-analysis of randomized controlled trials. *J Cardiovasc Pharmacol Therapeut.* 2016;21:167–76.
19. Pagani FD, Baker LS, Hsi C, Knox M, Fink MP, Visner MS. Left ventricular systolic and diastolic dysfunction after infusion of tumor necrosis factor-alpha in con- scious dogs. *J Clin Invest.* 1992;90:389–98.
20. Chandrasekar B, Mitchell DH, Colston JT, Freeman GL. Regula- tion of CCAAT/enhancer binding protein, inter- leukin-6, inter- leukin-6 receptor, and gp130 expres- sion during myocardial ischemia/reperfusion. *Circulation.* 1999;99:427–33.
21. McCord JM. Oxygen-derived free radicals in postischemic tissue injury. *N Engl J Med.* 1985;312:159–63.
22. Suleiman MS, Zacharowski K, Angelini GD. Inflammation response and cardioprotection during open-heart surgery: the importance of anaesthetics. *Br J Pharmacol.* 2008;153:21–33.
23. Grossmann M, Nakamura Y, Grumont R, Gerondakis S. New insights into the roles of Rel/NF-kappa B trans- cription factors in immune function, hemopoiesis and human disease. *Int J Biochem Cell Biol.* 1999;31:1209–19.
24. Kim YM, Guzik TJ, Zhang YH, Zhang MH, Kattach H, Ratna- tunga C, et al. A myocardial Nox2 containing NAD(P)H oxidase contributes to oxidative stress in hu- man atrial fibrillation. *Circ Res.* 2005;97:629–36.
25. Wu JH, Marchioli R, Silletta MG, Masson S, Sellke FW, Libby P et al. Oxidative Stress Biomarkers and Inciden- ce of Postopera- tive Atrial Fibrillation in the Omega-3 Fatty Acids for Prevention of Postoperative Atrial Fibril- lation (OPERA) Trial. *J Am Heart Assoc* 2015;4.
26. Eslami M, Badkoubeh RS, Mousavi M, Radmehr H, Salehi M, Tavakoli N, et al. Oral ascorbic acid in com- bination with beta- blockers is more effective than be- ta-blockers alone in the preven- tion of atrial fibrillation after coronary artery bypass grafting. *Tex Heart Inst J.* 2007;34:268–74.
27. Kalman JM, Munawar M, Howes LG, Louis WJ, Buxton BF, Gutteridge G, et al. Atrial fibrillation after coronary artery bypass grafting is associated with sympathetic ac- tivation. *Ann Thorac Surg.* 1995;60:1709–15.
28. Almassi GH, Schowalter T, Nicolosi AC, Aggarwal A, Moritz TE, Henderson WG, et al. Atrial fibrillation af- ter cardiac surgery: a major morbid event? *Ann Surg.* 1997;226:501.
29. Alex J, Guvendik L. Evaluation of ventral cardiac de- nervation as a prophylaxis against atrial fibrillation af- ter coronary artery bypass grafting. *Ann Thorac Surg.* 2005;79:517–20.
30. Melo J, Voigt P, Sonmez B, Ferreira M, Abecasis M, Re- bocho M, et al. Ventral cardiac denervation reduces the incidence of atrial fibrillation after coronary artery by- pass grafting. *J Thorac Cardiovasc Surg.* 2004;127:511–6.
31. Omran AS, Karimi A, Ahmadi H, Yazdanifard P, Sheikh Fahtol- lahi M, Tazik M. Prophylactic ventral cardiac de- nervation: does it reduce incidence of atrial fibrillation after coronary artery bypass grafting? *J Thorac Cardio- vasc Surg.* 2010;140:1036–9.
32. Van Wagoner DR, Pond AL, Lamorgese M, Ros- sie SS, McCarthy PM, Nerbonne JM. Atrial L-type Ca²⁺ currents and human atrial fibrillation. *Circ Res.* 1999;85:428–36.
33. Swartz MF, Fink GW, Lutz CJ, Taffet SM, Berenfeld O, Vikstrom KL, et al. Left versus right atrial difference in dominant fre- quency, K(+) channel transcripts, and fibrosis in patients devel- oping atrial fibrillation after cardiac surgery. *Heart Rhythm.* 2009;6:1415–22.
34. Kertai MD, Li YJ, Ji Y, Qi W, Lombard FW, Shah SH, et al. Genome-wide association study of new-onset atrial fib- rilla- tion after coronary artery bypass grafting surgery. *Am Heart J.* 2015;170(580–90):e28.
35. Kertai MD, Li YW, Li YJ, Shah SH, Kraus WE, Fontes ML, et al. G protein-coupled receptor kinase 5 gene polymorphisms are associated with postoperative atrial fibrillation after coronary artery bypass grafting in pa- tients receiving beta-blockers. *Circ Cardiovasc Genet.* 2014;7:625–33.
36. Gaudino M, Andreotti F, Zamparelli R, Di Castelnuovo A, Nasso G, Burzotta F et al. The -174G/C interleukin-6 polymorphism influences postoperative interleukin-6 levels and postoperative atrial fibrillation. Is atrial fib- rillation an inflammatory complica- tion? *Circulation* 2003;108 Suppl 1:Ii195–9.

37. Jeff JM, Donahue BS, Brown-Gentry K, Roden DM, Crawford DC, Stein CM, et al. Genetic variation in the beta1-adrenergic receptor is associated with the risk of atrial fibrillation after cardiac surgery. *Am Heart J.* 2014;167(101–08):e1.
38. Body SC, Collard CD, Shernan SK, Fox AA, Liu KY, Ritchie MD, et al. Variation in the 4q25 chromosomal locus predicts atrial fibrillation after coronary artery bypass graft surgery. *Circ Cardiovasc Genet.* 2009;2:499–506.
39. Shen J, Lall S, Zheng V, Buckley P, Damiano RJ Jr, Schuessler RB. The persistent problem of new-onset postoperative atrial fibrillation: a single-institution experience over two decades. *J Thorac Cardiovasc Surg.* 2011;141:559–70.
40. Villareal RP, Hariharan R, Liu BC, Kar B, Lee VV, Elayda M, et al. Postoperative atrial fibrillation and mortality after coronary artery bypass surgery. *J Am Coll Cardiol.* 2004;43:742–8.
41. Zaman AG, Archbold RA, Helft G, Paul EA, Curzen NP, Mills PG. Atrial fibrillation after coronary artery bypass surgery: a model for preoperative risk stratification. *Circulation.* 2000;101:1403–8.
42. Banach M, Rysz J, Drozdz JA, Okonski P, Misztal M, Barylski M, et al. Risk factors of atrial fibrillation following coronary artery bypass grafting: a preliminary report. *Circ J.* 2006;70:438–41.
43. Hashimoto K, Ilstrup DM, Schaff HV. Influence of clinical and hemodynamic variables on risk of supraventricular tachycardia after coronary artery bypass. *J Thorac Cardiovasc Surg.* 1991;101:56–65.
44. Gu J, Andreasen JJ, Melgaard J, Lundbye-Christensen S, Hansen J, Schmidt EB, et al. Preoperative electrocardiogram score for predicting new-onset postoperative atrial fibrillation in patients undergoing cardiac surgery. *J Cardiothorac Vasc Anesth.* 2017;31:69–76.
45. Levy F, Debry N, Labescat AL, Meimoun P, Malaquin D, Marechaux S, et al. Echocardiographic prediction of postoperative atrial fibrillation after aortic valve replacement for aortic stenosis: a two-dimensional speckle tracking left ventricular longitudinal strain multicentre pilot study. *Arch Cardiovasc Dis.* 2012;105:499–506.
46. Wazni OM, Martin DO, Marrouche NF, Latif AA, Ziada K, Shaaraoui M, et al. Plasma B-type natriuretic peptide levels predict postoperative atrial fibrillation in patients undergoing cardiac surgery. *Circulation.* 2004;110:124–7.
47. Basaran O, Tigen K, Gozubuyuk G, Dundar C, Guler A, Tasar O, et al. Predictive role of left atrial and ventricular mechanical function in postoperative atrial fibrillation: a two-dimensional speckle-tracking echocardiography study. *Turk Kardiyoloji Derneği arşivi: Turk Kardiyoloji Derneği yayın organıdır.* 2016;44:45–52.
48. Rivinus R, Helmschrott M, Ruhparwar A, Darche FF, Thomas D, Bruckner T, et al. Comparison of post-transplant outcomes in patients with no, acute, or chronic amiodarone use before heart transplantation. *Drug Design Dev Therapy.* 2017;11:1827–37.
49. Alp H, Narin C, Baysal T, Sarigul A. Prevalence of and risk factors for early postoperative arrhythmia in children after cardiac surgery. *Pediatr Int.* 2014;56:19–23.
50. Caretta Q, Mercanti CA, De Nardo D, Chiarotti F, Scibilia G, Reale A, et al. Ventricular conduction defects and atrial fibrillation after coronary artery bypass grafting. Multivariate analysis of preoperative, intraoperative and postoperative variables. *Eur Heart J.* 1991;12:1107–11.
51. Nair SG. Atrial fibrillation after cardiac surgery. *Ann Card Anaesth.* 2010;13:196–205.
52. Hoit BD, Shao Y, Tsai LM, Patel R, Gabel M, Walsh RA. Altered left atrial compliance after atrial appendectomy. Influence on left atrial and ventricular filling. *Circ Res.* 1993;72:167–75.
53. Nardi F, Diena M, Caimmi PP, Iraghi G, Lazzero M, Cerin G, et al. Relationship between left atrial volume and atrial fibrillation following coronary artery bypass grafting. *J Card Surg.* 2012;27:128–35.
54. Kirchhof P, Benussi S, Koteka D, Ahlsson A, Atar D, Casadei B, et al. 2016 ESC guidelines for the management of atrial fibrillation developed in collaboration with EACTS. *Eur Heart J.* 2016;37:2893–962.
55. Gillinov AM, Bagiella E, Moskowitz AJ, Raiten JM, Groh MA, Bowdish ME, et al. Rate control versus rhythm control for atrial fibrillation after cardiac surgery. *N Engl J Med.* 2016;374:1911–21.
56. Arsenault KA, Yusuf AM, Crystal E, Healey JS, Morillo CA, Nair GM, et al. Interventions for preventing postoperative atrial fibrillation in patients undergoing heart surgery. *Cochrane Datab Syst Rev.* 2013;Cd003611.
57. DiNicolantonio JJ, Beavers CJ, Menezes AR, Lavie CJ, O'Keefe JH, Meier P, et al. Meta-analysis comparing carvedilol versus metoprolol for the prevention of postoperative atrial fibrillation following coronary artery bypass grafting. *Am J Cardiol.* 2014;113:565–9.
58. Brinkman W, Herbert MA, O'Brien S, Filardo G, Prince S, Dewey T, et al. Preoperative beta-blocker use in coronary artery bypass grafting surgery: national database analysis. *JAMA Internal Med.* 2014;174:1320–7.
59. Auer J, Weber T, Berent R, Ng CK, Lamm G, Eber B. Risk factors of postoperative atrial fibrillation after cardiac surgery. *J Card Surg.* 2005;20:425–31.
60. Wijeyesundara DN, Beattie WS, Rao V, Karski J. Calcium antagonists reduce cardiovascular complications after cardiac surgery: a meta-analysis. *J Am Coll Cardiol.* 2003;41:1496–505.
61. Tisdale JE, Padhi ID, Goldberg AD, Silverman NA, Webb CR, Higgins RS, et al. A randomized, double-blind comparison of intravenous diltiazem and digoxin for atrial fibrillation after coronary artery bypass surgery. *Am Heart J.* 1998;135:739–47.
62. Buckley MS, Nolan PE Jr, Slack MK, Tisdale JE, Hilleman DE, Copeland JG. Amiodarone prophylaxis for atrial fibrillation after cardiac surgery: meta-analysis of dose response and timing of initiation. *Pharmacotherapy.* 2007;27:360–8.
63. Suttorp MJ, Kingma JH, Peels HO, Koomen EM, Tijsse JG, van Hemel NM, et al. Effectiveness of sotalol in preventing supraventricular tachyarrhythmias shortly after coronary artery bypass grafting. *Am J Cardiol.* 1991;68:1163–9.
64. VanderLugt JT, Mattioni T, Denker S, Torchiana D, Ahern T, Wakefield LK, et al. Efficacy and safety of ibuprofen for prevention of atrial fibrillation after coronary artery bypass grafting. *Am J Cardiol.* 2007;99:100–4.

- tilide fumarate for the conversion of atrial arrhythmias after cardiac surgery. *Circulation*. 1999;100:369–75.
65. Torp-Pedersen C, Moller M, Bloch-Thomsen PE, Kober L, San- doe E, Egstrup K et al. Dofetilide in patients with congestive heart failure and left ventricular dysfunction. Danish Investigations of Arrhythmia and Mortality on Dofetilide Study Group. *N Engl J Med* 1999;341:857–65.
 66. Fairley JL, Zhang L, Glassford NJ, Bellomo R. Magnesium status and magnesium therapy in cardiac surgery: a systematic review and meta-analysis focusing on arrhythmia prevention. *J Crit Care*. 2017;42:69–77.
 67. Gholipour Baradari A, Emami Zeydi A, Ghafari R, Aarabi M, Jafari M. A double-blind randomized clinical trial comparing different doses of magnesium in cardioplegic solution for prevention of atrial fibrillation after coronary artery bypass graft surgery. *Cardiovasc Ther*. 2016;34:276–82.
 68. Zheng Z, Jayaram R, Jiang L, Emberson J, Zhao Y, Li Q, et al. Perioperative rosuvastatin in cardiac surgery. *N Engl J Med*. 2016;374:1744–53.
 69. Billings FTt, Hendricks PA, Schildcrout JS, Shi Y, Petracek MR, Byrne JG et al. High-Dose Perioperative Atorvastatin and Acute Kidney Injury Following Cardiac Surgery: A Randomized Clinical Trial. *JAMA* 2016;315:877–88.
 70. Zheng Z, Jayaram R, Jiang LX, Emberson J, Zhao Y, Li Q, et al. Perioperative rosuvastatin in cardiac surgery. *N Engl J Med*. 2016;374:1744–53.
 71. Hemila H, Suonsyrja T. Vitamin C for preventing atrial fibrillation in high risk patients: a systematic review and meta-analysis. *BMC Cardiovasc Disord*. 2017;17:49.
 72. Mozaffarian D, Marchioli R, Macchia A, Silletta MG, Ferrazzi P, Gardner TJ, et al. Fish oil and postoperative atrial fibrillation: the Omega-3 Fatty Acids for Prevention of Post-operative Atrial Fibrillation (OPERA) randomized trial. *JAMA*. 2012;308:2001–11.
 73. Wang H, Chen J, Zhao L. N-3 polyunsaturated fatty acids for prevention of postoperative atrial fibrillation: updated meta-analysis and systematic review. *J Intervent Cardiac Electrophysiol*. 2018;51:105–15.
 74. Whitlock RP, Devereaux PJ, Teoh KH, Lamy A, Vincent J, Pogue J, et al. Methylprednisolone in patients undergoing cardiopulmonary bypass (SIRS): a randomised, double-blind, placebo-controlled trial. *Lancet (Lond, Engl)*. 2015;386:1243–53.
 75. Kazemi B, Akbarzadeh F, Safaei N, Yaghoubi A, Shadvar K, Ghasemi K. Prophylactic high-dose oral-N-acetylcysteine does not prevent atrial fibrillation after heart surgery: a prospective double blind placebo-controlled randomized clinical trial. *Pacing Clin Electrophysiol*. 2013;36:1211–9.
 76. Ozaydin M, Icli A, Yucel H, Akcay S, Peker O, Erdogan D et al. Metoprolol vs. carvedilol or carvedilol plus N-acetyl cysteine on post-operative atrial fibrillation: a randomized, double-blind, placebo-controlled study. *Eur Heart J* 2013;34:597–604.
 77. Imazio M, Brucato A, Ferrazzi P, Rovere ME, Gandino A, Cemin R, et al. Colchicine reduces postoperative atrial fibrillation: results of the Colchicine for the Prevention of the Postpericardiotomy Syndrome (COPPS) atrial fibrillation substudy. *Circulation*. 2011;124:2290–5.
 78. Imazio M, Brucato A, Ferrazzi P, Pullara A, Adler Y, Barosi A, et al. Colchicine for prevention of postpericardiotomy syndrome and postoperative atrial fibrillation: the COPPS-2 randomized clinical trial. *JAMA*. 2014;312:1016–23.
 79. Kowey PR, Dorian P, Mitchell LB, Pratt CM, Roy D, Schwartz PJ, et al. Vernakalant hydrochloride for the rapid conversion of atrial fibrillation after cardiac surgery: a randomized, double-blind, placebo-controlled trial. *Circ Arrhythm Electrophysiol*. 2009;2:652–9.
 80. Bidar E, Maesen B, Nieman F, Verheule S, Schotten U, Maessen JG. A prospective randomized controlled trial on the incidence and predictors of late-phase postoperative atrial fibrillation up to 30 days and the preventive value of biatrial pacing. *Heart Rhythm*. 2014;11:1156–62.
 81. Maaroos M, Halonen J, Kiviniemi V, Hartikainen J, Hakala T. Intravenous metoprolol versus biatrial pacing in the prevention of atrial fibrillation after coronary artery bypass surgery: a prospective randomized open trial. *Scand J Surg*. 2012;101:292–6.
 82. Kuralay E, Ozal E, Demirkili U, Tatar H. Effect of posterior pericardiotomy on postoperative supraventricular arrhythmias and late pericardial effusion (posterior pericardiotomy). *J Thorac Cardiovasc Surg*. 1999;118:492–5.
 83. Biancari F, Maher MA. Meta-analysis of randomized trials on the efficacy of posterior pericardiotomy in preventing atrial fibrillation after coronary artery bypass surgery. *J Thorac Cardiovasc Surg*. 2010;139:1158–61.
 84. McKeown P, Epstein AE. Future directions: American College of Chest Physicians guidelines for the prevention and management of postoperative atrial fibrillation after cardiac surgery. *Chest*. 2005;128:61s–4s.
 85. Anderson E, Johnke K, Leedahl D, Glogoza M, Newman R, Dyke C. Novel oral anticoagulants vs warfarin for the management of postoperative atrial fibrillation: clinical outcomes and cost analysis. *Am J Surg* 2015;210:1095–102; (discussion 102–3).
 86. Sezai A, Osaka S, Yaoita H, Arimoto M, Hata H, Shiono M. Safety of the direct oral anticoagulant edoxaban for atrial fibrillation after cardiac surgery: pilot study. *J Atrial Fibrill*. 2016;9:1456.
 87. Friedman DJ, Piccini JP, Wang T, Zheng J, Malaisrie SC, Holmes DR, et al. Association between left atrial appendage occlusion and readmission for thromboembolism among patients with atrial fibrillation undergoing concomitant cardiac surgery. *JAMA*. 2018;319:365–74.
 88. Yao X, Gersh BJ, Holmes DR Jr, Melduni RM, Johnsrud DO, Sangaralingham LR, et al. Association of surgical left atrial appendage occlusion with subsequent stroke and mortality among patients undergoing cardiac surgery. *JAMA*. 2018;319:2116–26.
 89. Cameron MJ, Tran DTT, Abboud J, Newton EK, Rashidian H, Dupuis JY. Prospective external validation of three preoperative risk scores for prediction of new onset atrial fibrillation after cardiac surgery. *Anesth Analg*. 2018;126:33–8.
 90. Kolek MJ, Muehlschlegel JD, Bush WS, Parvez B, Murray KT, Stein CM, et al. Genetic and clinical risk prediction model for postoperative atrial fibrillation. *Circ Arrhythm Electrophysiol*. 2015;8:25–31.