

Characteristics of United States Military Pilots with Atrial Fibrillation

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Abstract

INTRODUCTION

Atrial fibrillation (AF) is a recognized disqualifying condition for United States military pilots impacting deployments and retention. This study aims to characterize United States active duty (AD) pilots with AF and review deployment and retention rates associated with medical and ablative therapies.

METHODS

An observational analysis was performed to assess AD pilots diagnosed with AF in the largest military regional healthcare system from 2004 to 2019. Baseline characteristics and AF management were reviewed.

RESULTS

27 AD pilots (mean age, 37.3 ± 7.9 years; mean BMI, 27.3 ± 3.1 kg/m²; 100% male sex) were diagnosed with AF during the study dates. 17 (63%) were Air Force pilots with hypertension as the most common risk factor (26%) and overall low CHA₂DS₂-VASc scores (mean 0.29 ± 0.47). 22 (82%) pilots evenly received medical rate and rhythm strategies (41% and 41%, respectively). 16 (59%) underwent pulmonary vein isolation (PVI) with zero complications. 11 (41%) pilots received warfarin and 5 (19%) received a direct oral anticoagulant (DOAC) for stroke prevention. After diagnosis 12 (44%) pilots deployed and 25 (93%) were military retained. PVI was not associated with a change in subsequent deployments rates (PVI, 38% vs No PVI, 55%; $p=0.3809$) or retention rates (PVI, 94% vs no PVI, 91%; $p=0.7835$).

CONCLUSIONS

United States military pilots diagnosed with AF are younger patients with few traditional AF risk factors. They receive medical rate and rhythm strategies equally. Many pilots maintain deployment eligibility and most remain on AD status after diagnosis. PVI is not associated with changes in retention or deployment rates.

Introduction

Atrial fibrillation (AF), a cardiac rhythm disorder commonly associated with increasing age,¹ is now readily recognized to confer a five-fold increased lifetime risk of AF in athletic individuals compared with sedentary populations.² A chronic hypertension diagnosis² only imparts a 1.42-fold increased risk of AF as the most common traditional underlying risk factor.^{3,4} The pathophysiology of AF in athletes and other similar populations is incompletely understood but is theorized to be related to large fluctuations in vagal tone, atrial stretching mechanisms, and increased inflammation associated with high levels of endurance exercise.² The prevalence and epidemiology of AF in the athletic population has been predominately drawn from retrospective and case control studies and the literature lacks prospective studies carefully

quantifying exercise exposures in this population.⁵⁻¹⁰ Identified risk factors for AF within the athletic population include male sex, middle age, tall stature, participation in endurance athletics, lifetime exercise of greater than 1500–2000 hours, and high occupational physical activity.^{1, 11-13}

Active duty (AD) military personnel and military pilots are mandated to maintain a high level of physical fitness compared with the general population to fulfill their occupational duties and have similar physical profiles to athletes diagnosed with AF as described in the literature.¹⁴⁻¹⁶ In addition to elevated physical fitness standards compared to the average individual, military pilots are specifically exposed to other unique and known precipitants of AF: reduced partial pressures of oxygen at high altitudes, sustained acceleration and gravitational forces, and physical and emotional stress related to combat flying.^{17, 18} AF can be highly symptomatic and potentially incapacitating with resultant dire consequences for pilots while operating aircrafts.^{17, 18} Furthermore, AF can be a grounding medical condition for AD pilots with substantial global impacts on military deployments, readiness, and retention.^{19, 20} The diagnosis of AF in itself does not automatically preclude continued military service provided that the individual continues to maintain fitness for general military duty requirements.

The AF treatment approach in military pilots has been traditionally individualized in accordance with guideline recommendations.²¹ There is currently no clear and documented consensus on the appropriate management or military disposition for AD pilots with AF diagnoses as there are no prior reports on their demographics or historical military dispositions. This lack of standardized management is further compounded by the current broader discussions and controversies surrounding medical rate and rhythm strategies in the general population.¹ Catheter ablation is an alternative and invasive option demonstrated to be effective in eliminating AF and improving exercise tolerance in several small studies of endurance athletes but the safety and utilization in military pilots has not been previously described.²²⁻²⁴ There are currently no reports describing these treatment approaches in military pilots diagnosed with AF. This study aims to describe United States AD military pilots diagnosed with AF and characterize the long-term outcomes associated with the medical and ablative therapies received.

Methods

Study Design

AD military pilots within the San Antonio Military Health System (United States Air Force, Army, and Navy services) who were diagnosed with AF between January 1, 2004 to July 31, 2019 (n = 27) were included and retrospectively reviewed. Eligibility criteria included AD status at time of diagnosis, pilot, and confirmed 12-lead electrocardiographic diagnosis of AF by a board-certified cardiologist. Exclusion criteria were retired military, military dependents, other dysrhythmias, and alternate or unknown occupation. Distribution of baseline characteristics, medical therapies, and deployment and retention rates were evaluated by electronic medical record and medical board documentation review. Servicemember retention was defined as someone who was not discharged from the service and

remained on AD status throughout the duration of the study. Military members were classified as serving a deployment if they were mobilized for determined mission critical purposes or duty tours.

Statistical Methods

The association between management therapies, future deployments, and military disposition was analyzed using Chi Square and Fisher's Exact Test for categorical variables. The T-Test was used for comparison of continuous variables. Due to the sample size we relied on central limit theorem and did not test normality assumption. This research protocol was approved by the institutional review board of the San Antonio Military Medical Center. The institutional review board of San Antonio Military Medical Center waived the need for informed consent because the research involved no more than minimal risk to the participants and the waiver did not adversely affect their rights and welfare. Data analysis was performed using JMP statistical analysis software Version 15 (SAS Institute, Cary, NC).

Patient and Public Involvement

Patients and the public were not directly involved in the research process given the retrospective, observational nature of the study.

Results

There were 27 male AD pilots with a mean age of 37.3 ± 7.9 years, mean BMI of 27.3 ± 3.1 kg/m² and predominately Caucasian race (85%) (Table 1, 2). 17 (63%) were Air Force pilots and the majority had paroxysmal AF (93%). Hypertension and obstructive sleep apnea were present in 26% and 19%, respectively. There was a collective mean CHA₂DS₂-VASc score of 0.29 ± 0.47 and a mean HAS-BLED score of 0.74 ± 0.53 . The cohort overall had few cardiovascular risk factors and no known history of underlying cardiovascular disease (Table 1, 2). After AF diagnoses, 12 (44%) pilots completed deployments and 25 (93%) were retained on AD military status (Table 3). Two members separated or retired, both for reasons unrelated to AF. Two pilots with persistent AF were retained but never deployed after their diagnosis.

Table 1
Demographic characteristics of active duty military pilots diagnosed with atrial fibrillation and relationship to medical treatment strategy.

	All (n = 27)	No medical therapy (n = 5)	Rate control (n = 11)	Rhythm control (n = 11)	p- value
Age, years	37.3 ± 7.9	29.2 ± 6.2	40.3 ± 7.2	38.0 ± 7.1	0.0147
Male, No. (%)	27 (100%)	5 (100%)	11 (100%)	11 (100%)	N/A
BMI, kg/m ²	27.3 ± 3.1	25.0 ± 3.8	28.8 ± 3.1	26.9 ± 1.8	0.1408
Caucasian, No. (%)	23 (85%)	5 (100%)	7 (64%)	11 (100%)	N/A
African American, No. (%)	1 (4%)	0 (0%)	1 (9%)	0 (0%)	N/A
Other race/unknown race, No. (%)	3 (11%)	0 (0%)	3 (27%)	0 (0%)	N/A
Hypertension, No. (%)	7 (26%)	1 (20%)	3 (27%)	3 (27%)	0.9431
Obstructive sleep apnea, No. (%)	5 (19%)	1 (20%)	2 (18%)	2 (18%)	0.9956
Diabetes mellitus, No. (%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	N/A
Vascular disease, No. (%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	N/A
Prior TIA or CVA, No. (%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	N/A
Coronary artery disease, No. (%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	N/A
History of heart failure, No. (%)	1 (4%)	0 (0%)	1 (9%)	0 (0%)	0.3961
Glucose, mg/dL	92.1 ± 11.5	93.8 ± 15.4	92.5 ± 8.5	91.1 ± 13.3	0.3401
Total cholesterol, mg/dL	187.5 ± 27.0	194.2 ± 17.6	189.5 ± 34.9	182.5 ± 22.2	0.2335
LDL, mg/dL	117.8 ± 22.7	108.3 ± 21.1	123.3 ± 27.8	115.8 ± 17.7	0.3409
HDL, mg/dL	47.7 ± 9.9	57.1 ± 13.7	45.2 ± 5.8	46.0 ± 2.9	0.0612
Triglycerides, mg/dL	115.6 ± 82.2	148.0 ± 156.7	110.9 ± 69.6	105.5 ± 47.3	0.8181
CHA ₂ DS ₂ -VASc score	0.29 ± 0.47	0.20 ± 0.45	0.36 ± 0.50	0.27 ± 0.47	0.5732

	All (n = 27)	No medical therapy (n = 5)	Rate control (n = 11)	Rhythm control (n = 11)	p- value
HAS-BLED score	0.74 ± 0.53	0.80 ± 0.45	0.64 ± 0.67	0.82 ± 0.40	0.3706
<i>AF classification</i>					
Paroxysmal AF, No. (%)	25 (93%)	5 (100%)	11 (100%)	9 (82%)	N/A
Persistent AF, No. (%)	2 (7%)	0 (0%)	0 (0%)	2 (18%)	N/A
Permanent AF, No. (%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	N/A
Abbreviations: AF, atrial fibrillation; BMI, body mass index (calculated as kg divided by meters squared); CVA, cerebrovascular accident; HDL, high density lipoprotein; LDL, low density lipoprotein; N/A, not applicable; TIA, transient ischemic attack					
Values are number (%), mean (± 1 standard deviation)					

Table 2

Demographic characteristics of active duty military pilots diagnosed with atrial fibrillation who underwent pulmonary vein isolation compared to pilots without pulmonary vein isolations.

	All (n = 27)	No PVI (n = 11)	PVI (n = 16)	p-value
Age, years	37.3 ± 7.9	34.6 ± 7.9	39.1 ± 7.5	0.1519
Male, No. (%)	27 (100%)	11 (100%)	16 (100%)	N/A
BMI, kg/m ²	27.3 ± 3.1	26.3 ± 3.4	28.0 ± 2.7	0.2564
Caucasian, No. (%)	23 (85%)	10 (91%)	13 (81%)	N/A
African American, No. (%)	1 (4%)	0 (0%)	1 (6%)	N/A
Other race/unknown, No. (%)	3 (11%)	1 (9%)	2 (13%)	N/A
Hypertension, No. (%)	7 (26%)	2 (18%)	5 (31%)	0.9024
Obstructive sleep apnea, No. (%)	5 (19%)	2 (18%)	3 (19%)	0.9702
Diabetes mellitus, No. (%)	0 (0%)	0 (0%)	0 (0%)	N/A
Vascular disease, No. (%)	0 (0%)	0 (0%)	0 (0%)	N/A
Prior TIA or CVA, No. (%)	0 (0%)	0 (0%)	0 (0%)	N/A
Coronary artery disease, No. (%)	0 (0%)	0 (0%)	0 (0%)	N/A
History of heart failure, No. (%)	1 (4%)	1 (9%)	0 (0%)	0.1735
Glucose, mg/dL	92.1 ± 11.5	93.0 ± 11.5	91.6 ± 11.9	0.7295
Total cholesterol, mg/dL	187.5 ± 27.0	189.1 ± 21.0	186.4 ± 31.0	0.7671
LDL, mg/dL	117.8 ± 22.7	115.0 ± 17.0	119.6 ± 26.0	0.9790
HDL, mg/dL	47.7 ± 9.9	49.0 ± 12.8	46.9 ± 7.6	0.9803
Triglycerides, mg/dL	115.6 ± 82.2	130.5 ± 120.0	105.4 ± 42.9	0.6568
CHA ₂ DS ₂ -VASc score	0.29 ± 0.47	0.27 ± 0.47	0.31 ± 0.48	0.8273
HAS-BLED score	0.74 ± 0.53	0.91 ± 0.54	0.63 ± 0.50	0.1875
<i>AF classification</i>				
Paroxysmal, No. (%)	25 (93%)	10 (91%)	15 (94%)	N/A
Persistent, No. (%)	2 (7%)	1 (9%)	1 (6%)	N/A
Permanent, No. (%)	0 (0%)	0 (0%)	0 (0%)	N/A

	All (n = 27)	No PVI (n = 11)	PVI (n = 16)	p-value
Abbreviations: AF, atrial fibrillation; BMI, body mass index (calculated as kg divided by meters squared); CVA, cerebrovascular accident; HDL, high density lipoprotein; LDL, low density lipoprotein; N/A, not applicable; PVI, pulmonary vein isolation; TIA, transient ischemic attack				
Values are number (%), mean (\pm 1 standard deviation)				

Table 3
Military retention and deployment rates in active duty pilots diagnosed with atrial fibrillation comparing medical and ablative treatment strategies.

	All (n = 27)	Retained (n = 25)	Discharged (n = 2)	Deployed (n = 12)	Non-deployed (n = 15)
<i>Medical therapies for AF</i>					
No medical therapy	5 (19%)	5 (80%)	0 (0%)	5 (42%)	0 (0%)
Rate control agent	11 (41%)	9 (36%)	2 (100%)	4 (33%)	7 (47%)
Rhythm control agent	11 (41%)	11 (44%)	0 (0%)	3 (25%)	8 (53%)
<i>Rates of PVI for AF</i>					
No PVI	11 (41%)	10 (40%)	1 (50%)	6 (50%)	5 (33%)
PVI	16 (59%)	15 (60%)	1 (50%)	6 (50%)	10 (67%)
<i>Anticoagulation management for AF</i>					
No anticoagulation	11 (41%)	11 (44%)	0 (0%)	6 (50%)	5 (33%)
Warfarin	11 (41%)	10 (40%)	1 (50%)	5 (42%)	6 (40%)
Direct oral anticoagulants	5 (19%)	4 (16%)	1 (50%)	1 (8%)	4 (27%)
Abbreviations: AF, atrial fibrillation; PVI, pulmonary vein isolation					
Values are number, (%)					

A total of 22 (82%) pilots evenly received rate and rhythm medications (41% and 41%, respectively). Rate and rhythm medical treatment strategies were not different in their association with deployment rates (rate control, 36% vs rhythm control, 27%; $p = 0.6467$). Pilots who did not receive any medical therapy had 100% deployment rates and this was statistically significant when compared to pilots treated with rate control ($p = 0.0288$) or rhythm control agents ($P = 0.0128$). There was no significant difference in retention rates amongst the treatment groups (no medical therapy, 100% vs rate control, 82% vs rhythm control, 100%; $p = 0.1475$).

There were 16 (59%) participants who underwent pulmonary vein isolation (PVI) without complications. Of these, six underwent repeat PVI for AF recurrence. PVI was not associated with a change in subsequent deployment rate (PVI, 38% vs No PVI, 55%; $p = 0.3809$) or retention rate (PVI, 94% vs no PVI, 91%; $p = 0.7835$).

11 (41%) pilots previously received warfarin and five (19%) previously received a direct oral anticoagulant (DOAC) for chronic stroke prevention or transient periprocedural anticoagulation. There were no reported strokes in this study group nor bleeding complications in pilots who previously received systemic anticoagulation. There were no differences in deployment rates between prior anticoagulation strategies (no anticoagulant therapy, 55% vs warfarin, 45%, vs DOAC 20%; $p = 0.4116$), however there was a non-statistically significant trend toward fewer deployments in those treated with DOACs. There was no significant difference in military dispositions in association with prior anticoagulation strategy, with most pilots retained across all groups (no anticoagulant, 100% vs warfarin, 80% vs DOAC, 91%; $p = 0.2790$).

Discussion

This is the first report describing AF management in United States AD military pilots; a predominately younger cohort with few AF or cardiovascular risk factors. AD pilots had low estimated stroke risks by CHA_2DS_2-VASc scores and low estimated bleeding risks by HAS-BLED scores. Overall, many military pilots were able to complete deployments and met military retention standards after AF diagnosis, 44% and 93%, respectively. Only two patients in the cohort did not remain on AD status for non-medical reasons unrelated to their AF diagnosis. When AD pilots were observed to receive no medical or ablative therapies and had no prior history of anticoagulation there were 100% deployment and retention rates; strongly reflective of a low symptom burden of AF and low impact on completing occupational duties.

Just over half of the study pilots were previously treated with anticoagulants after diagnosis; predominantly warfarin and some with DOACs. We strongly suspect that the indication for systemic anticoagulation was largely driven by procedural interventions such as cardioversions and ablations instead of chronic stroke prevention given the overall low mean CHA_2DS_2-VASc of this cohort. Further, the observed association of anticoagulation utilization and deployments in this retrospective review is limited without clear temporal relationships available. Hence, we would not conclude that our results are suggestive of military pilots being universally cleared, safe or automatically eligible to deploy to all austere conditions while on systemic anticoagulation but instead provide evidence of some pilots being treated for a duration of time and still having capacity to deploy in the future.

Military pilots in this study received medical rate and rhythm control strategies equally. Rate and rhythm control agents were not associated with significant differences in retention or deployment rates. Absence of pharmacologic therapy was associated with a greater deployment rate when compared with those who received rate or rhythm medications and this may be reflective of those particular pilots having a low baseline AF burden and symptomology not requiring any medical therapy as previously discussed.

PVIs were performed in nearly 60% of patients without complications. Six of 16 underwent repeat PVI for AF recurrence, which might be explained by some theories. First, this could be reflective of aggressive efforts to maintain sinus rhythm and preserve flying status in light of AF recurrences. Second, this could be suggestive of substantial joint efforts between patients and providers to avoid medical therapy and the entailing side effect profiles. PVI did not significantly influence deployment or retention rates in this small cohort but this data does highlight the safety of the procedure in special, younger population as there were zero complications. This study was not specifically designed to evaluate the efficacy of PVI for AF in military pilots but it does bring to question the PVI efficacy of reducing AF burden and morbidity outcomes in the military pilot population.

Limitations of this study include the lack of diversity in patients, small cohort size, and retrospective constraints. Further, this retrospective review allows us only to draw associations between therapies and outcomes without concluding direct cause and effect relationships. Despite these limitations we feel the data presented in this study offer value to military and civilian providers given the paucity of literature surrounding military pilots.

There is little data to guide management decisions in young, AD United States military pilots. No prior studies describe pharmacologic treatment strategies or PVI in this unique, mission critical population. This study highlights the need for further research on the efficacy of AF therapies on symptomatology and recurrences in military pilots along with other younger demographic profiles in high-risk occupations.

Conclusion

United States military pilots diagnosed with AF are younger patients with few traditional AF risk factors. In this small cohort they receive medical rate and rhythm strategies equally, maintain deployment eligibility, and most remain on AD status after diagnosis. PVI is not associated with changes in retention or deployment rates. Multicenter prospective studies are needed to better characterize the appropriate management of AF in the military pilot population.

Abbreviations

AD, active duty; AF, atrial fibrillation; BMI, body mass index; CVA, cerebrovascular accident; DOAC, direct oral anticoagulant; HDL, high density lipoprotein; LDL, low density lipoprotein; N/A, not applicable; PVI, pulmonary vein isolation; TIA, transient ischemic attack

Declarations

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CONTRIBUTORS

The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. ANK, JMS, and KNVB conceived the idea for the study and drafted the protocol. ANK, ASW, AY, and JMS completed data collection. Data analysis was completed by ANK and KNVB. ANK composed the initial manuscript draft, however all authors provided critical feedback and contributed to the final manuscript. KNVB supervised the study.

CONSENT FOR PUBLICATION

Not applicable

FUNDING AND COMPETING INTERESTS

No funding was received for this study and the authors have no conflicts of interest to declare. All authors have completed the Unified Competing Interest form (available on request from the corresponding author) and declare: no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work.

ETHICAL APPROVAL

This study was approved by the institutional review board of the Brooke Army Medical Center (Protocol Number FWH20190113H). which waived the need for informed consent because the research involved no more than minimal risk to the participants and the waiver did not adversely affect their rights and welfare.

DATA SHARING

The full dataset is available from the corresponding author (kelvin.n.bush.mil@mail.mil) upon request. Participant consent for data sharing was not obtained but the presented data are anonymized and risk of identification is low.

TRANSPARENCY

The guarantor affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as originally planned have been explained.

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References

1. Raju H, Kalman JM. Management of Atrial Fibrillation in the Athlete. *Heart Lung Circ.* 2018; 27(9): 1086-1092.
2. Sharma S, Merghani A, Mont L. Exercise and the heart: the good, the bad, and the ugly. *Eur Heart J.* 2015; 36(23): 1445-1453.
3. Krahn AD, Manfreda J, Tate RB, Mathewson FA, Cuddy TE. The natural history of atrial fibrillation: incidence, risk factors, and prognosis in the Manitoba Follow-Up Study. *Am J Med.* 1995; 98(5): 476-484.
4. Kannel WB, Abbott RD, Savage DD, McNamara PM. Epidemiologic features of chronic atrial fibrillation: the Framingham study. *N Engl J Med.* 1982; 306(7): 1018-1022.
5. Baldesberger S, Bauersfeld U, Candinas R, et al. Sinus node disease and arrhythmias in the long-term follow-up of former professional cyclists. *Eur Heart J.* 2008; 29(1): 71-78.
6. Karjalainen J, Kujala UM, Kaprio J, Sarna A, Viitasalo M. Lone atrial fibrillation in vigorously exercising middle aged men: case-control study. *BMJ.* 1998; 7147; 1784-1785.
7. Elosua R, Arquer A, Mont L, et al. Sport practice and the risk of lone atrial fibrillation: a case-control study. *Int J Cardiol.* 2006; 108(3): 332-337.
8. Claessen G, Colyn E, La Gerche A, et al. Long-term endurance sport is a risk factor for development of lone atrial flutter. *Heart.* 2011; 97(11): 918-22.
9. Grimsmo J, Grundvold I, Maehlum S, Arnesen H. High prevalence of atrial fibrillation in long-term endurance cross-country skiers: echocardiographic findings and possible predictors– a 28-30 years follow-up study. *Eur J Cardiovasc Prev Rehabil.* 2010; 17(1): 100-105.
10. Molina L, Mont L, Marrugat J, et al. Long-term endurance sport practice increases the incidence of lone atrial fibrillation in men: a follow-up study. *Europace.* 2008; 10(5): 618-623.
11. Flannery MD, Kalman JM, Sanders P, Gerche AL. State of the Art Review: Atrial Fibrillation in Athletes. *Heart Lung Circ.* 2017; 26(9): 983-989)
12. Skielboe AK, Marott JL, Dixen U, Friberg JB, Jensen GB. Occupational physical activity, but not leisure-time physical activity increases the risk of atrial fibrillation: The Copenhagen City Heart Study. *Eur J Prev Cardiol.* 2016; 23(17): 1883-1893.
13. Wilhelm M. Atrial fibrillation in endurance athletes. *Eur J Prev Cardiol.* 2014; 21(8): 1040-1048.
14. Army Physical Fitness Test (APFT). 2012; Appendix A: A1-24.
15. Guide 5, Physical Readiness Test (PRT), Guide 5: Physical Readiness Test (PRT). Navy Phys Readiness Progr. 2019; 1-42.
16. S. Air Force. Air Force instruction 36-2905: Personnel fitness program. Washington, DC: US Government Printing Office 2013; 1-147.

17. Hunter AH, Timperley AC, Reid ANC, McLoughlin DC, Nicol E. A 5-year Review of Atrial Fibrillation in Military Aircrew. *Aviat Space Environ Med.* 2013; 84(12): 1249-1254.
18. Guettler N, Bron D, Manen O, et al. Management of cardiac conduction abnormalities and arrhythmia in aircrew. *Heart.* 2019; 105(suppl 1): s38-s49.
19. DoD Instruction 6130.03 Medical Standards for Appointment, Enlistment, or Induction into the Military Services. 2018; 1-18.
20. S. Air Force. Air Force Instruction 48-123: Medical examinations and standards. Washington, DC: US Government Printing Office 2013; 24-50.
21. January CT, Wann LS, Calkins H, et al. 2019 AHA/ACC/HRS focused update of the 2014 AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society. *J Am Coll Cardiol.* 2019; 74(1), 104-132.
22. Furlanello F, Bertoldi A, Dallago M, et al. Atrial fibrillation in elite athletes. *J Cardiovasc Electrophysiol* 1998; 9(8 suppl): s63-s68.
23. Calvo N, Mont L, Tamborero D, et al. Efficacy of circumferential pulmonary vein ablation of atrial fibrillation in endurance athletes. *Europace.* 2010; 12(1): 30-36.
24. Koopman P, Nuyens D, Garweg C, et al. Efficacy of radiofrequency catheter ablation in athletes with atrial fibrillation. *Europace.* 2011; 13(10): 1386-1393.