ACC Middle East Conference 2018

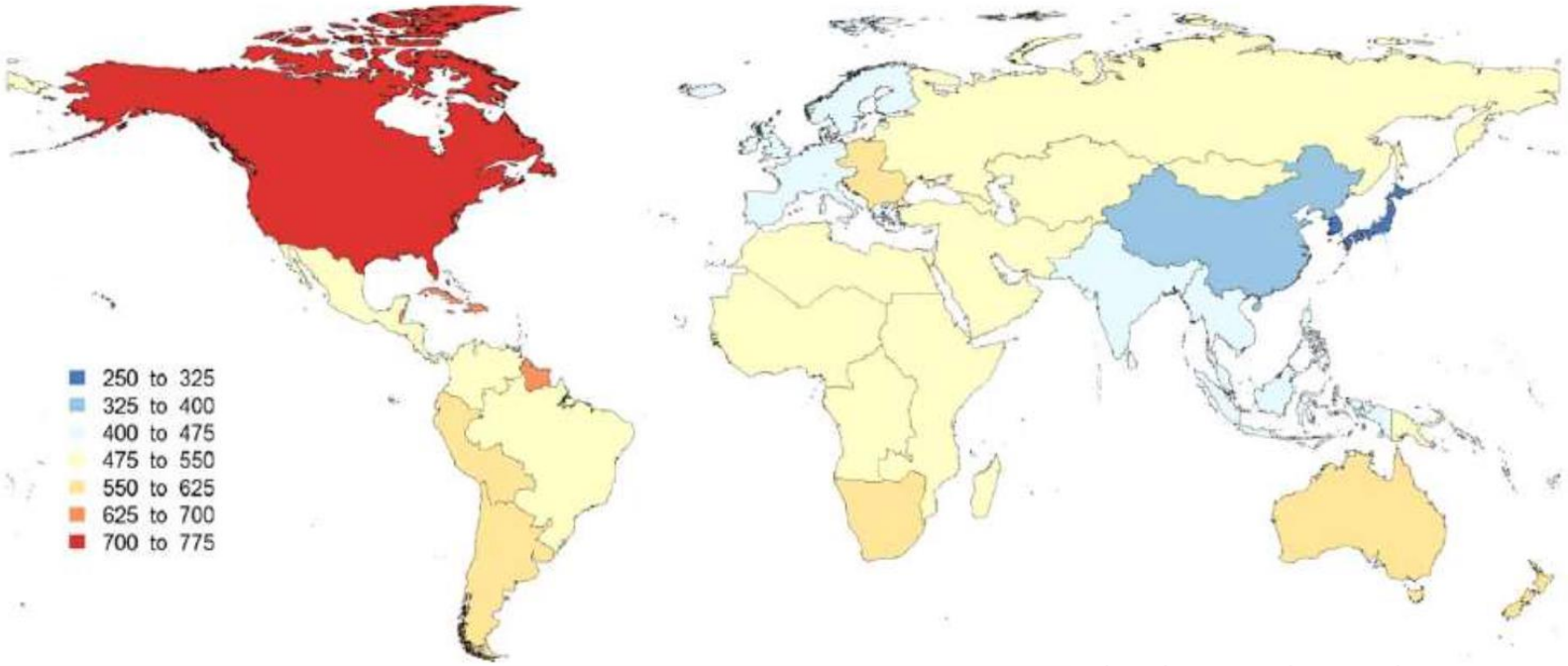
In partnership with:

جمعية القلب السعودية
Saudi Heart Association

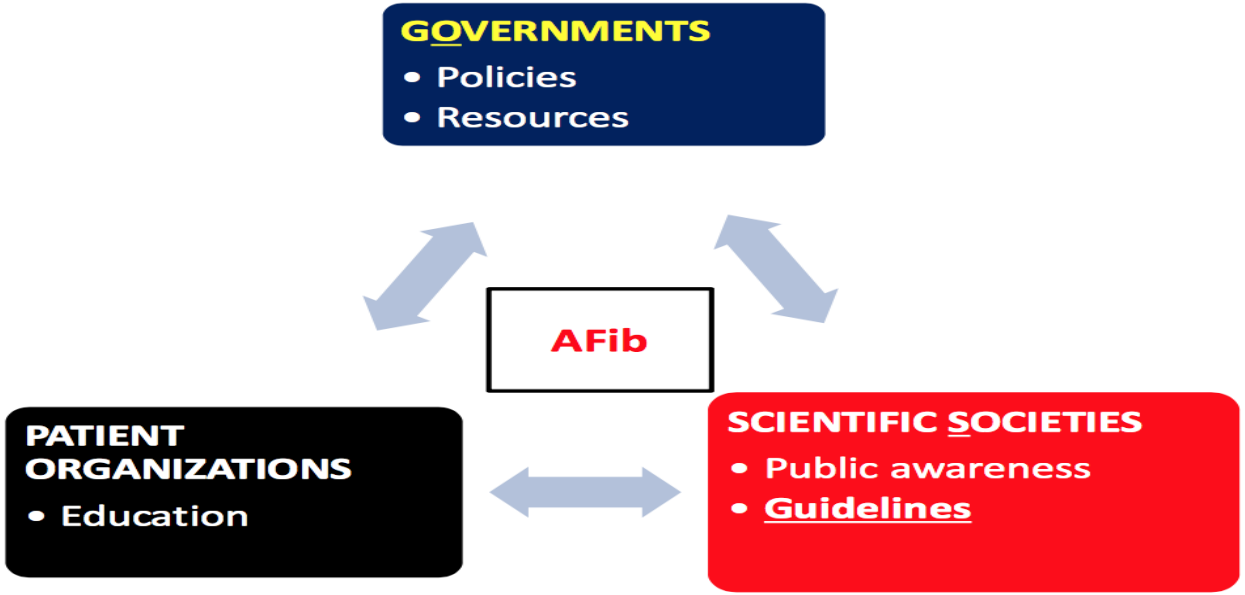
AF GUIDELINES UPDATE

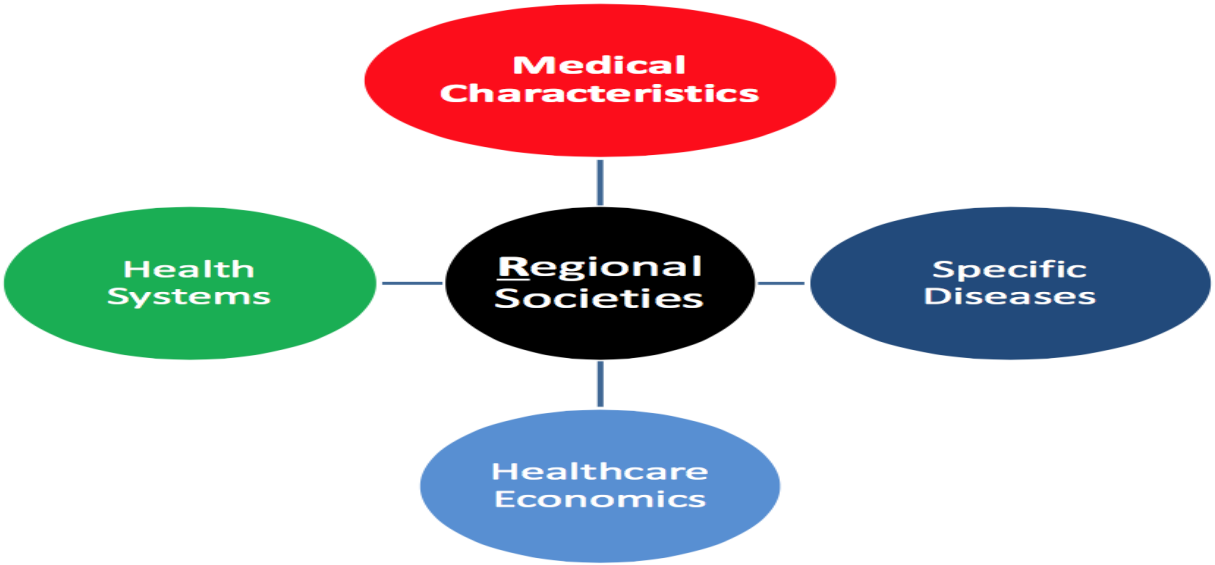
Naeem Alshoaibi, MBBS, FACC, FRCPC
Consultant of Cardiac Electrophysiology
Head of Adult Cardiology Unit
King Abdulaziz University
@naeemalshoaibi

Prevalence of atrial fibrilation and flutter (per 100,000) by region, 2010



Chugh S, et al. Circulation 2014


GOVERNMENTS
• Policies
• Resources
AFib
PATIENT ORGANIZATIONS
• Education
SCIENTIFIC SOCIETIES
• Public awareness
• Guidelines


Medical Characteristics
Health Systems
Regional Societies
Specific Diseases
Healthcare Economics


Heart Rhythm Society
EUROPEAN Heart Rhythm ASSOCIATION
LAHRS
APHRS

Contemporary Atrial Fibrillation Management: A Comparison of the Current AHA/ACC/HRS, CCS, and ESC Guidelines.

- Definition AF
- Symptom score
- Stroke risk scores
- Role of aspirin
- Antithrombotic regimens CAD

- Rate control target
- Role of "first-line" catheter ablation
- Open surgical ablation
- Left atrial appendage exclusion

Andrade J. Can J Cardiol. 2017

2007 Consensus Document

HRS/EHRA/ECAS Expert Consensus Statement on Catheter and Surgical Ablation of Atrial Fibrillation: Recommendations for Personnel, Policy, Procedures and Follow-Up

A report of the Heart Rhythm Society (HRS) Task Force on Catheter and Surgical Ablation of Atrial Fibrillation.
Developed in partnership with the European Heart Rhythm Association (EHRA) and the European Cardiac Arrhythmia Society (ECAS); in collaboration with the American College of Cardiology (ACC), American Heart Association (AHA), and the Society of Thoracic Surgeons (STS).
Endorsed and Approved by the governing bodies of the American College of Cardiology, the American Heart Association, the European Cardiac Arrhythmia Society, the European Heart Rhythm Association, the Society of Thoracic Surgeons, and the Heart Rhythm Society.

Hugh Calkins, MD, FHRS; Josep Brugada, MD, FESC; Douglas L. Packer, MD, FHRS;
Riccardo Cappato, MD, FESC; Shih-Ann Chen, MD, FHRS; Harry J.G. Crijns, MD, FESC;
Ralph J. Damiano, Jr., MD; D. Wyn Davies, MD, FHRS; David E. Haines, MD, FHRS;
Michel Haissaguerre, MD; Yoshito Iesaka, MD; Warren Jackman, MD, FHRS; Pierre Jais, MD;
Hans Kottkamp, MD; Karl Heinz Kuck, MD, FESC; Bruce D. Lindsay, MD FHRS;
Francis E. Marchlinski, MD; Patrick M. McCarthy, MD; J. Lluis Mont, MD, FESC; Fred Morady, MD;
Koonlawee Nademanee, MD; Andrea Natale, MD, FHRS; Carlo Pappone, MD, PhD;
Eric Prystowsky, MD, FHRS; Antonio Raviele, MD, FESC; Jeremy N. Ruskin, MD; Richard J. Shemin, MD

Heart Rhythm 2007 June 4(6) 816-61

2012 Consensus Document

2012 HRS/EHRA/ECAS Expert Consensus Statement on Catheter and Surgical Ablation of Atrial Fibrillation: Recommendations for Patient Selection, Procedural Techniques, Patient Management and Follow-up, Definitions, Endpoints, and Research Trial Design

A report of the Heart Rhythm Society (HRS) Task Force on Catheter and Surgical Ablation of Atrial Fibrillation. Developed in partnership with the European Heart Rhythm Association (EHRA), a registered branch of the European Society of Cardiology (ESC) and the European Cardiac Arrhythmia Society (ECAS); and in collaboration with the American College of Cardiology (ACC), American Heart Association (AHA), the Asia Pacific Heart Rhythm Society (APHRS), and the Society of Thoracic Surgeons (STS). Endorsed by the governing bodies of the American College of Cardiology Foundation, the American Heart Association, the European Cardiac Arrhythmia Society, the European Heart Rhythm Association, the Society of Thoracic Surgeons, the Asia Pacific Heart Rhythm Society, and the Heart Rhythm Society

Hugh Calkins, MD, FACC, FHRS, FAHA; Karl Heinz Kuck, MD, FESC; Riccardo Cappato, MD, FESC; Josep Brugada, MD, FESC; A. John Camm, MD, PhD; Shih-Ann Chen, MD, FHRS[§]; Harry J.G. Crijns, MD, PhD, FESC; Ralph J. Damiano, Jr., MD[^]; D. Wyn Davies, MD, FHRS; John DiMarco, MD, PhD, FACC, FHRS; James Edgerton, MD, FACC, FACS, FACCP[^]; Kenneth Ellenbogen, MD, FHRS; Michael D. Ezekowitz, MD; David E. Haines, MD, FHRS; Michel Haissaguerre, MD; Gerhard Hindricks, MD; Yoshito Iesaka, MD[$]; Warren Jackman, MD, FHRS; José Jalife, MD, FHRS; Pierre Jais, MD; Jonathan Kalman, MD[$]; David Keane, MD; Young-Hoon Kim, MD, PhD[$]; Paulus Kirchhof, MD; George Klein, MD; Hans Kottkamp, MD; Koichiro Kumagai, MD, PhD[$]; Bruce D. Lindsay, MD, FHRS[**]; Moussa Mansour, MD; Francis E. Marchlinski, MD; Patrick M. McCarthy, MD[^]; J. Lluis Mont, MD, FESC; Fred Morady, MD; Koonlawee Nademanee, MD; Hiroshi Nakagawa, MD, PhD, Andrea Natale, MD, FHRS[‡]; Stanley Nattel, MD; Douglas L. Packer, MD, FHRS; Carlo Pappone, MD, PhD; Eric Prystowsky, MD, FHRS; Antonio Raviele, MD, FESC; Vivek Reddy, MD; Jeremy N. Ruskin, MD; Richard J. Shemin, MD[^]; Hsuan-Ming Tsao, MD[$]; David Wilber, MD

Heart Rhythm 2012 Apr; 9(4) 632-696

2017 HRS/EHRA/ECAS/APHRS/SOLAECE expert consensus statement on catheter and surgical ablation of atrial fibrillation

Hugh Calkins, MD (Chair),[1] Gerhard Hindricks, MD (Vice-Chair),[2,*] Riccardo Cappato, MD (Vice-Chair),[3,¶] Young-Hoon Kim, MD, PhD (Vice-Chair),[4,§] Eduardo B. Saad, MD, PhD (Vice-Chair),[5,‡] Luis Aguinaga, MD, PhD,[6,‡] Joseph G. Akar, MD, PhD,[7] Vinay Badhwar, MD,[8,#] Josep Brugada, MD, PhD,[9,*] John Camm, MD,[10,*] Peng-Sheng Chen, MD,[11] Shih-Ann Chen, MD,[12,§] Mina K. Chung, MD,[13] Jens Cosedis Nielsen, DMSc, PhD,[14,*] Anne B. Curtis, MD,[15,‖] D. Wyn Davies, MD,[16,¶] John D. Day, MD,[17] André d'Avila, MD, PhD,[18,††] N.M.S. (Natasja) de Groot, MD, PhD,[19,*] Luigi Di Biase, MD, PhD,[20,*] Mattias Duytschaever, MD, PhD,[21,*] James R. Edgerton, MD,[22,#] Kenneth A. Ellenbogen, MD,[23] Patrick T. Ellinor, MD, PhD,[24] Sabine Ernst, MD, PhD,[25,*] Guilherme Fenelon, MD, PhD,[26,‡] Edward P. Gerstenfeld, MS, MD,[27] David E. Haines, MD,[28] Michel Haissaguerre, MD,[29,*] Robert H. Helm, MD,[30] Elaine Hylek, MD, MPH,[31] Warren M. Jackman, MD,[32] Jose Jalife, MD,[33] Jonathan M. Kalman, MBBS, PhD,[34,§] Josef Kautzner, MD, PhD,[35,*] Hans Kottkamp, MD,[36,*] Karl Heinz Kuck, MD, PhD,[37,*] Koichiro Kumagai, MD, PhD,[38,§] Richard Lee, MD, MBA,[39,#] Thorsten Lewalter, MD, PhD,[40,¶] Bruce D. Lindsay, MD,[41] Laurent Macle, MD,[42,**] Moussa Mansour, MD,[43] Francis E. Marchlinski, MD,[44] Gregory F. Michaud, MD,[45,†] Hiroshi Nakagawa, MD, PhD,[46] Andrea Natale, MD,[47] Stanley Nattel, MD,[48] Ken Okumura, MD, PhD,[49,††] Douglas Packer, MD,[50] Evgeny Pokushalov, MD, PhD,[51,*] Matthew R. Reynolds, MD, MSc,[52] Prashanthan Sanders, MBBS, PhD,[53] Mauricio Scanavacca, MD, PhD,[54,‡] Richard Schilling, MD,[55,*] Claudio Tondo, MD, PhD,[56,*] Hsuan-Ming Tsao, MD,[57,§] Atul Verma, MD,[58] David J. Wilber, MD,[59] Teiichi Yamane, MD, PhD[60,††]

Heart Rhythm. 2017 Oct;14(10):e275-e444. PMID: 28506916

Europace. 2017 Sep 15. doi: 10.1093 PMID: 29016840

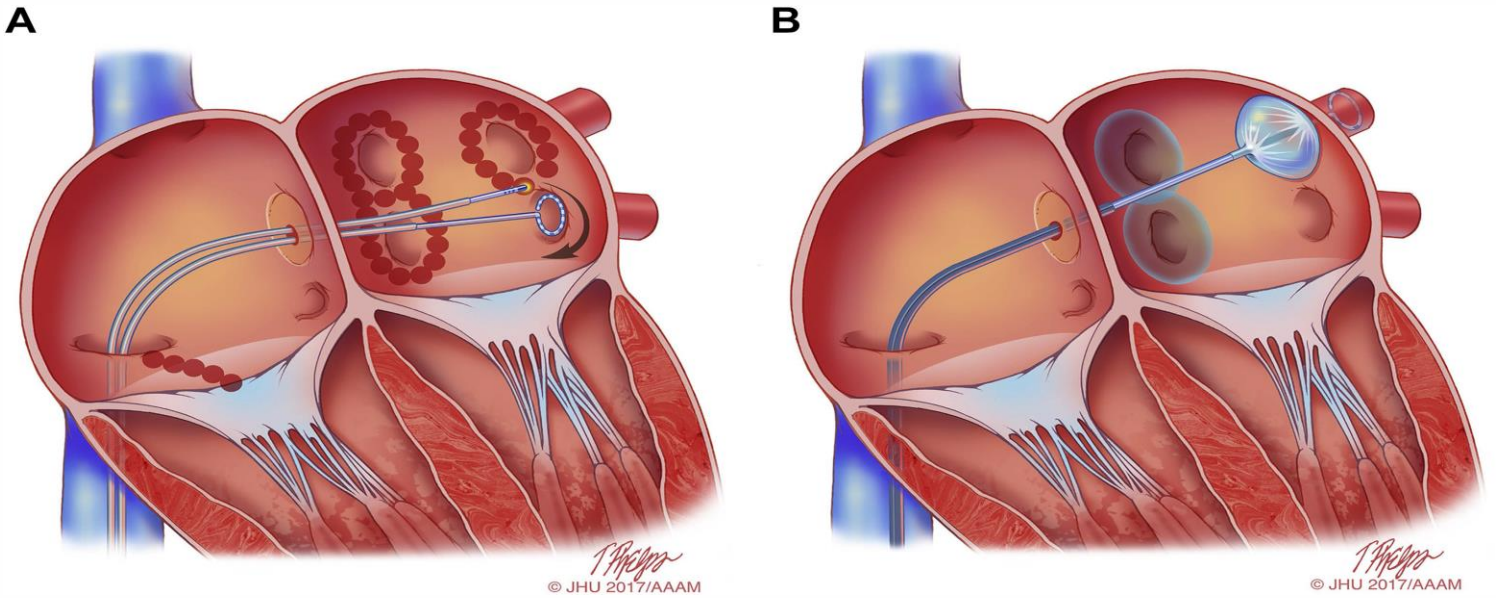
J Arrhythm. 2017 Oct;33(5):369-409 PMID: 29021841

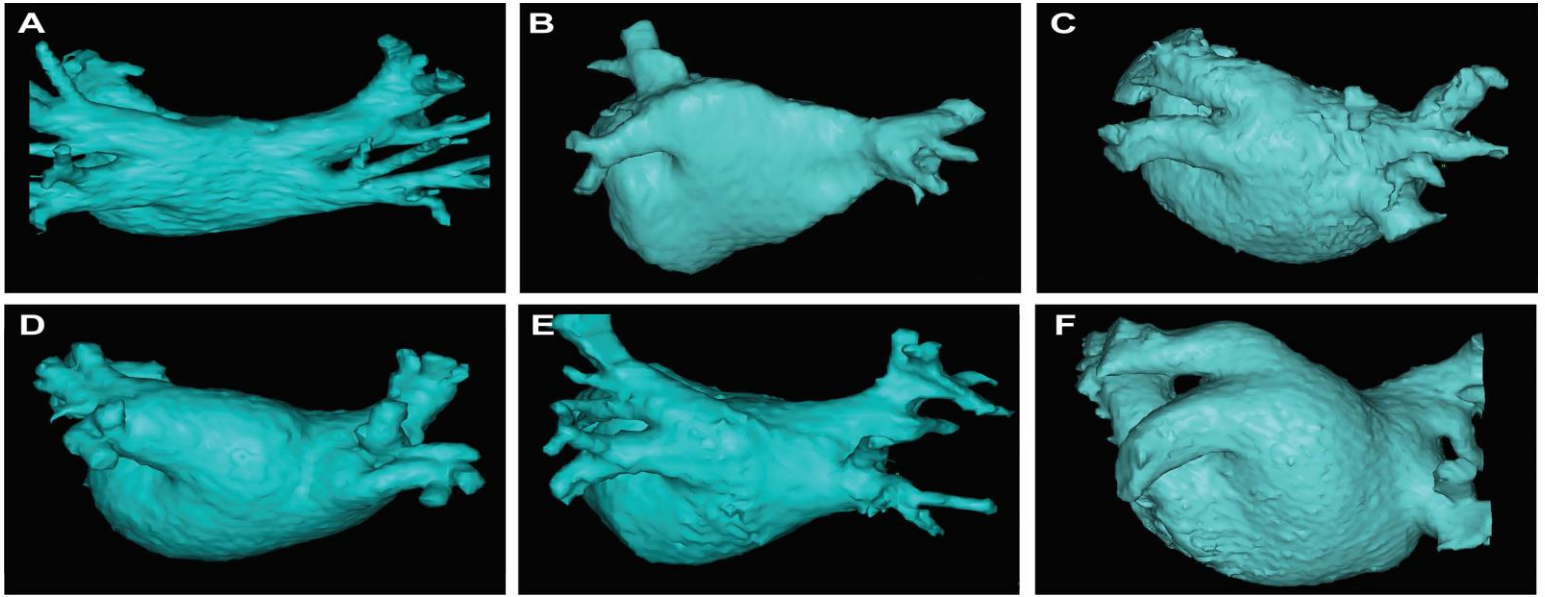
Outline

1. Overview of the 2017 Consensus Document
2. Document highlights
3. Areas of Controversy
4. Conclusion

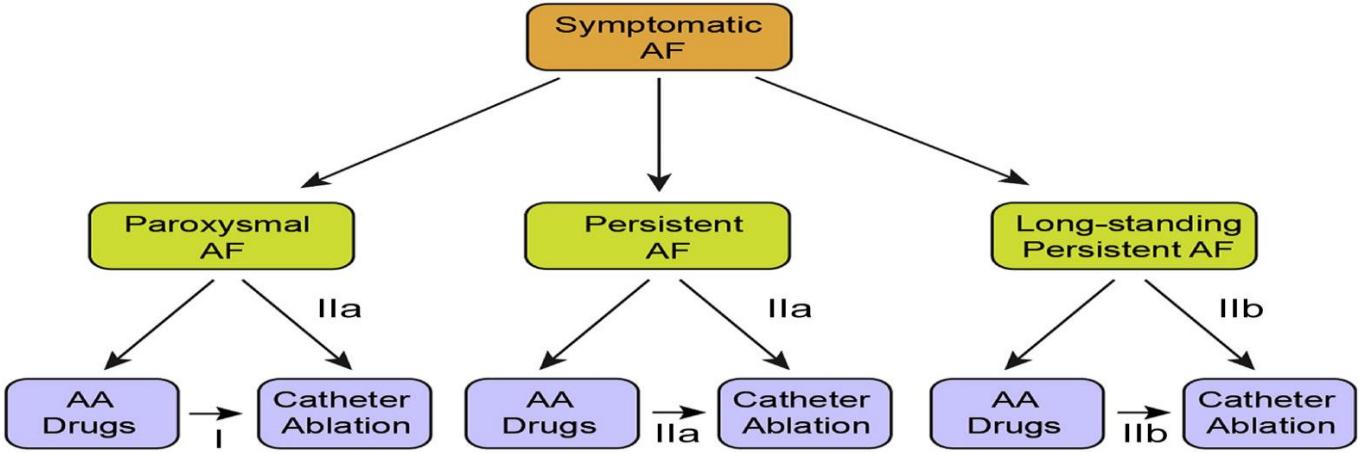
HRS/ EHRA/ ECAS/ APHRS/ SOLAECE EXPERT CONSENSUS STATEMENT ON CATHETER AND SURGICAL ABLATION OF ATRIAL FIBRILLATION – 14 SECTIONS

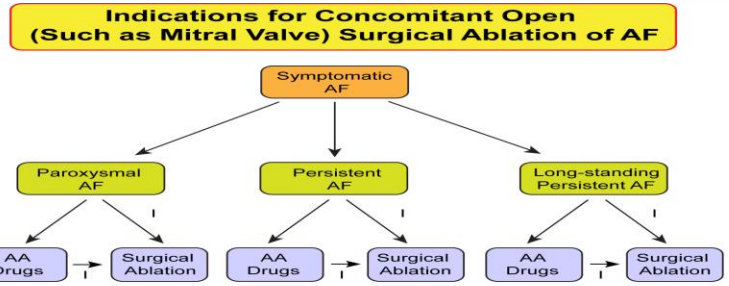
- *Introduction*
- *Definitions, Mechanisms, and Rationale for Ablation*
- *Modifiable Risk Factors for AF and Impact on Ablation*
- *Indications for Catheter and Surgical Ablation of Atrial Fibrillation*
- *Strategies, Techniques and Endpoints for AF ablation*
- *Technology and tools*
- *Other technical aspects to maximize safety and anticoagulation*
- *Follow-up Considerations*
- *Outcomes and Efficacy*
- *Complications*
- *Training requirements and competencies*
- *Surgical ablation of AF*
- *Clinical trial design*
- *Conclusion*

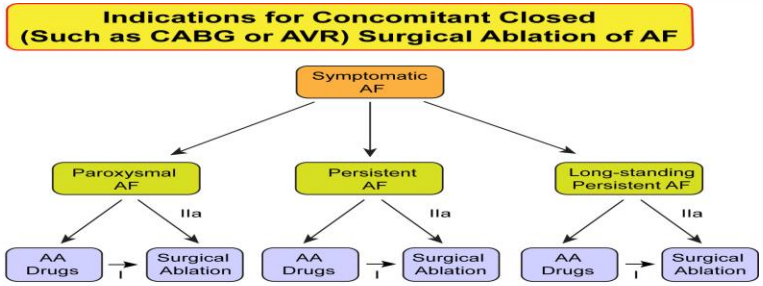

A
B
© JHU 2017/AAAM
© JHU 2017/AAAM

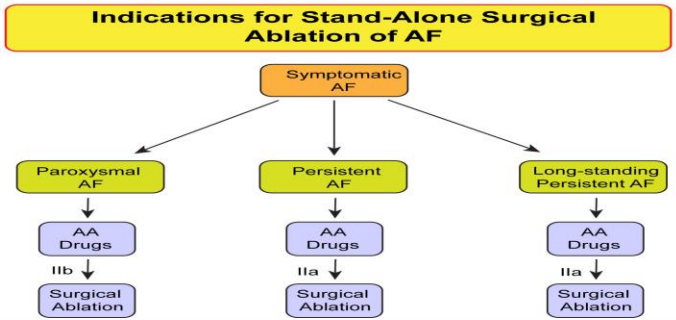

A
B
C
D
E
F

Indications for Catheter Ablation of Symptomatic Atrial Fibrillation




Indications for Concomitant Open (Such as Mitral Valve) Surgical Ablation of AF
Symptomatic AF
Paroxysmal AF
Persistent AF
Long-standing Persistent AF
I
AA Drugs
Surgical Ablation


Indications for Concomitant Closed (Such as CABG or AVR) Surgical Ablation of AF
Symptomatic AF
Paroxysmal AF
Persistent AF
Long-standing Persistent AF
IIa
AA Drugs
Surgical Ablation


Indications for Stand-Alone Surgical Ablation of AF
Symptomatic AF
Paroxysmal AF
Persistent AF
Long-standing Persistent AF
AA Drugs
IIb
IIa
Surgical Ablation

	Recommendation	Class	LOE	References
Indications for catheter ablation of atrial fibrillation				
A. Indications for catheter ablation of atrial fibrillation				
Symptomatic AF refractory or intolerant to at least one Class I or III antiarrhythmic medication	Paroxysmal: Catheter ablation is recommended.	I	A	7–18
	Persistent: Catheter ablation is reasonable.	IIa	B-NR	8,16–26
	Long-standing persistent: Catheter ablation may be considered.	IIb	C-LD	8,16–26
Symptomatic AF prior to initiation of antiarrhythmic therapy with a Class I or III antiarrhythmic medication	Paroxysmal: Catheter ablation is reasonable.	IIa	B-R	27–35
	Persistent: Catheter ablation is reasonable.	IIa	C-EO	
	Long-standing persistent: Catheter ablation may be considered.	IIb	C-EO	

B. Indications for catheter atrial fibrillation ablation in populations of patients not well represented in clinical trials

Congestive heart failure	It is reasonable to use similar indications for AF ablation in selected patients with heart failure as in patients without heart failure.	IIa	B-R	36–52
Older patients (>75 years of age)	It is reasonable to use similar indications for AF ablation in selected older patients with AF as in younger patients.	IIa	B-NR	53–59
Hypertrophic cardiomyopathy	It is reasonable to use similar indications for AF ablation in selected patients with HCM as in patients without HCM.	IIa	B-NR	60–62
Young patients (<45 years of age)	It is reasonable to use similar indications for AF ablation in young patients with AF (<45 years of age) as in older patients.	IIa	B-NR	63,64
Tachy-brady syndrome	It is reasonable to offer AF ablation as an alternative to pacemaker implantation in patients with tachy-brady syndrome.	IIa	B-NR	33–35
Athletes with AF	It is reasonable to offer high-level athletes AF as first-line therapy due to the negative effects of medications on athletic performance.	IIa	C-LD	27,28,65
Asymptomatic AF**	Paroxysmal: Catheter ablation may be considered in select patients.**	IIb	C-EO	66,67
	Persistent: Catheter ablation may be considered in select patients.	IIb	C-EO	68

	Recommendation	Class	LOE
Preablation	For patients undergoing AF catheter ablation who have been therapeutically anticoagulated with warfarin or dabigatran, performance of the ablation procedure without interruption of warfarin or dabigatran is recommended.	I	A
	For patients undergoing AF catheter ablation who have been therapeutically anticoagulated with rivaroxaban, performance of the ablation procedure without interruption of rivaroxaban is recommended.	I	B-R
	For patients undergoing AF catheter ablation who have been therapeutically anticoagulated with a NOAC other than dabigatran or rivaroxaban, performance of the ablation procedure without withholding a NOAC dose is reasonable.	IIa	B-NR
	Anticoagulation guidelines that pertain to cardioversion of AF should be adhered to in patients who present for an AF catheter ablation procedure.	I	B-NR
	For patients anticoagulated with a NOAC prior to AF catheter ablation, it is reasonable to hold one to two doses of the NOAC prior to AF ablation with reinitiation postablation.	IIa	B-NR
	Performance of a TEE in patients who are in AF on presentation for AF catheter ablation and who have been receiving anticoagulation therapeutically for 3 weeks or longer is reasonable	IIa	C-EO
	Performance of a TEE in patients who present for ablation in sinus rhythm and who have not been anticoagulated prior to catheter ablation is reasonable.	IIa	C-EO
	Use of intracardiac echocardiography to screen for atrial thrombi in patients who cannot undergo TEE may be considered.	IIb	C-EO

More Anticoagulation Strategies

During ablation	Heparin should be administered prior to or immediately following transseptal puncture during AF catheter ablation procedures and adjusted to achieve and maintain an ACT of at least 300 seconds.	I	B-NR
	Administration of protamine following AF catheter ablation to reverse heparin is reasonable.	IIa	B-NR
Postablation	In patients who are not therapeutically anticoagulated prior to catheter ablation of AF and in whom warfarin will be used for anticoagulation postablation, low molecular weight heparin or intravenous heparin should be used as a bridge for initiation of systemic anticoagulation with warfarin following AF ablation*.	I	C-EO
	Systemic anticoagulation with warfarin* or a NOAC is recommended for at least 2 months postcatheter ablation of AF.	I	C-EO
	Adherence to AF anticoagulation guidelines is recommended for patients who have undergone an AF ablation procedure, regardless of the apparent success or failure of the procedure.	I	C-EO
	Decisions regarding continuation of systemic anticoagulation more than 2 months post ablation should be based on the patient's stroke risk profile and not on the perceived success or failure of the ablation procedure.	I	C-EO
	In patients who have not been anticoagulated prior to catheter ablation of AF or in whom anticoagulation with a NOAC or warfarin has been interrupted prior to ablation, administration of a NOAC 3 to 5 hours after achievement of hemostasis is reasonable postablation.	IIa	C-EO
	Patients in whom discontinuation of anticoagulation is being considered based on patient values and preferences should consider undergoing continuous or frequent ECG monitoring to screen for AF recurrence.	IIb	C-EO

Nonablation strategies to improve outcomes

Weight loss can be useful for patients with AF, including those who are being evaluated to undergo an AF ablation procedure, as part of a comprehensive risk factor management strategy.	IIa	B-R
It is reasonable to consider a patient's BMI when discussing the risks, benefits, and outcomes of AF ablation with a patient being evaluated for an AF ablation procedure.	IIa	B-R
It is reasonable to screen for signs and symptoms of sleep apnea when evaluating a patient for an AF ablation procedure and to recommend a sleep evaluation if sleep apnea is suspected.	IIa	B-R
Treatment of sleep apnea can be useful for patients with AF, including those who are being evaluated to undergo an AF ablation procedure.	IIa	B-R
The usefulness of discontinuation of antiarrhythmic drug therapy prior to AF ablation in an effort to improve long-term outcomes is unclear.	IIb	C-LD
The usefulness of initiation or continuation of antiarrhythmic drug therapy during the postablation healing phase in an effort to improve long-term outcomes is unclear.	IIb	C-LD

If a patient has a history of typical atrial flutter or typical atrial flutter is induced at the time of AF ablation, delivery of a cavotricuspid isthmus linear lesion is recommended.	I	B-R	
If linear ablation lesions are applied, operators should use mapping and pacing maneuvers to assess for line completeness.	I	C-LD	
If a reproducible focal trigger that initiates AF is identified outside the PV ostia at the time of an AF ablation procedure, ablation of the focal trigger should be considered.	IIa	C-LD	
When performing AF ablation with a force-sensing RF ablation catheter, a minimal targeted contact force of 5 to 10 grams is reasonable.	IIa	C-LD	

Ablation strategies to be considered for use in conjunction with PV isolation

Posterior wall isolation might be considered for initial or repeat ablation of persistent or long-standing persistent AF.	IIb	C-LD
Administration of high-dose isoproterenol to screen for and then ablate non-PV triggers may be considered during initial or repeat AF ablation procedures in patients with paroxysmal, persistent, or long-standing persistent AF.	IIb	C-LD
DF-based ablation strategy is of unknown usefulness for AF ablation.	IIb	C-LD
The usefulness of creating linear ablation lesions in the right or left atrium as an initial or repeat ablation strategy for	IIb	B-NR
The usefulness of linear ablation lesions in the absence of macroreentrant atrial flutter is not well established.	IIb	C-LD
The usefulness of mapping and ablation of areas of abnormal myocardial tissue identified with voltage mapping or MRI as an initial or repeat ablation strategy for persistent or long-standing persistent AF is not well established.	IIb	B-R
The usefulness of ablation of complex fractionated atrial electrograms as an initial or repeat ablation strategy for persistent and long-standing persistent AF is not well established.	IIb	B-R
The usefulness of ablation of rotational activity as an initial or repeat ablation strategy for persistent and long-standing persistent AF is not well established.	IIb	B-NR
The usefulness of ablation of autonomic ganglia as an initial or repeat ablation strategy for paroxysmal, persistent, and long-standing persistent AF is not well established.	IIb	B-NR

	Recommendation	Class	LOE	References
PV isolation by catheter ablation	Electrical isolation of the PVs is recommended during all AF ablation procedures.	I	A	7–16,19–26,109
	Achievement of electrical isolation requires, at a minimum, assessment and demonstration of entrance block into the PV.	I	B-R	7–16,19–26,109
	Monitoring for PV reconnection for 20 minutes following initial PV isolation is reasonable.	IIa	B-R	9,110–120
	Administration of adenosine 20 minutes following initial PV isolation using RF energy with reablation if PV reconnection might be considered.	IIb	B-R	109,111–114,120–128
	Use of a pace-capture (pacing along the ablation line) ablation strategy may be considered.	IIb	B-R	129–133

Careful identification of the PV ostia is mandatory to avoid ablation within the PVs.	I	B-NR
It is recommended that RF power be reduced when creating lesions along the posterior wall near the esophagus.	I	C-LD
It is reasonable to use an esophageal temperature probe during AF ablation procedures to monitor esophageal temperature and help guide energy delivery.	IIa	C-EO

Top Controversies

1) Can anticoagulation be stopped more than 2 months post ablation if a patient is AF free and has a high stroke risk profile ?
2) Should we include an indication for AF ablation in asymptomatic patients ?
3) Class and level of indication for concomitant and stand alone surgical AF ablation.

Conclusions

- The 2017 HRS/ EHRA/ ECAS Expert Consensus Statement on catheter and surgical ablation of AF provides a comprehensive and up to date review of the indications, techniques, and outcomes of catheter and surgical ablation of atrial fibrillation.
- Indications for catheter and surgical ablation of AF are defined.
- Anticoagulation strategies prior to and following AF ablation are made.
- Recommendation for clinical trials are included.

Case

- 58 Year old, M, DM2, HTN, BMI 32, IHD, PCI (LAD)
- EF: 45%, PAF, CHADSVASC: 3
- Recurrent bleeding from angiodisplasia
- Bleeding on Apixaban, Dabigatran, Warfarin
- Watchman in 2016, now on Plavix only (no more bleeding)
- Still symptomatic PAF on (sotalol)

Next? : Amiodarone , Ablation

Thanks

Summary of Major Clinical Trials

Table 7 Selected clinical trials of catheter ablation of atrial fibrillation and/or for FDA approval

Trial	Year	Type	*N*	AF type	Ablation strategy	Initial time frame	Effectiveness endpoint	Ablation success	Drug/ Control success	*P* value for success	Ablation complications	Drug/Control complications	Comments
Clinical Trials Performed for FDA Approval													
JAMA 2010; 303: 333-340 (ThermoCool AF)[6,64]	2010	Randomized to RF ablation or AAD, multicenter	167	Paroxysmal	PVI, optional CFAEs and lines	12 months	Freedom from symptomatic paroxysmal atrial fibrillation, acute procedural failure, or changes in specified drug regimen	66%	16%	<0.001	4.9%	8.8%	FDA approval received
JACC 2013; 61: 1713-1723 (STOP AF)[66,c]	2013	Randomized to cryoballoon ablation or AAD, multicenter	245	Paroxysmal	PVI	12 months	Freedom from any detectable AF, use of nonstudy AAD, or nonprotocol intervention for AF	70%	7%	<0.001	3.1%	NA	FDA approval received
Heart Rhythm 2014; 11: 202-209 (TTOP)[7,a]	2014	Randomized to phased RF ablation or AAD/ cardioversion, multicenter	210	Persistent	PVI + CFAEs	6 months	Acute procedural success, ≥90% reduction in AF burden, off AAD	56%	26%	<0.001	12.3%	NA	Not FDA approved
JACC 2014; 64: 647-656 (SMART-AF)[9,73]	2014	Nonrandomzied multicenter study of contact force-sensing RF catheter, comparing to performance goals	172	Paroxysmal	PVI, optional CFAEs and lines	12 months	Freedom from symptomatic AF, flutter, tachycardia, acute procedural failure, or changes in AAD	72.5%	N/A	<0.0001	7.5%	NA	FDA approval received
Circulation 2015; 132: 907-915 (TOCCASTAR)[8,65]	2015	Randomized to contact force sensing RF catheter or approved RF catheter, multicenter	300	Paroxysaml	PVI, optional triggers, CAFEs and lines in both arms	12 months	Acute procedural succes + Freedom from Symptomatic AF/ Flutter/Tachycardia off AAD	67.8%	69.4%	0.0073 for noninferiority	7.2%	9.1%	FDA approval received
JACC 2015; 66: 1350-1360 (HeartLight)[b,28]	2015	Randomized to laserballoon or approved RF catheter, multicenter	353	Paroxysmal	PVI ± CTI ablation vs PVI, optional CFAEs, and Lines	12 months	Freedom from Symptomatic AF/ Flutter/Tachycardia, acute procedural failure, AAD, or non-prototocol intervention	61.1%	61.7%	0.003 for noninferiority	5.3%	6.4%	FDA approval received
NEJM 2016; 374: 2235-2245 (FIRE AND ICE)[10]	2016	Randomized RF vs Cryo, multicenter	762	Paroxysmal AF	PVI (focal)	12 months	Freedom from detectable AF, flutter, tachycardia	64.1% (RF)	65.4% (cryo)	NS	12.8%	10.2%	

Table 5 Signs and symptoms following AF ablation

	Differential	Suggested evaluation
Signs and symptoms of complications within a month postablation		
Back pain	Musculoskeletal, retroperitoneal hematoma	Physical exam, CT imaging
Chest pain	Pericarditis, pericardial effusion, coronary stenosis (ablation related), pulmonary vein stenosis, musculoskeletal (after cardioversion), worsening reflux	Physical exam, chest X-ray, ECG, echocardiogram, stress test, cardiac catheterization, chest CT
Cough	Infectious process, bronchial irritation (mechanical, cryoballoon), pulmonary vein stenosis	Physical exam, chest X-ray, chest CT
Dysphagia	Esophageal irritation (related to transesophageal echocardiography), atrioesophageal fistula	Physical exam, chest CT or MRI
Early satiety, nausea	Gastric denervation	Physical exam, gastric emptying study
Fever	Infectious process, pericarditis, atrioesophageal fistula	Physical exam, chest X-ray, chest CT, urinalysis, laboratory blood work
Fever, dysphagia, neurological symptoms	Atrial esophageal fistula	Physical exam, laboratory blood work, chest CT or MRI; avoid endoscopy with air insufflation
Groin pain at site of access	Pseudoaneurysm, AV fistula, hematoma	Ultrasound of the groin, laboratory blood work; consider CT scan if ultrasound negative
Headache	Migraine (related to anesthesia or transseptal access, hemorrhagic stroke), effect of general anesthetic	Physical exam, brain imaging (MRI)
Hypotension	Pericardial effusion/tamponade, bleeding, sepsis, persistent vagal reaction	Echocardiography, laboratory blood work
Hemoptysis	PV stenosis or occlusion, pneumonia	Chest X-ray, chest CT or MR scan, VQ scan
Neurological symptoms	Cerebral embolic event, atrial esophageal fistula	Physical exam, brain imaging, chest CT or MRI
Shortness of breath	Volume overload, pneumoma, pulmonary vein stenosis, phrenic nerve injury	Physical exam, chest X-ray, chest CT, laboratory blood work
Signs and symptoms of complications more than a month postablation		
Fever, dysphagia, neurological symptoms	Atrial esophageal fistula	Physical exam, laboratory blood work, chest CT or MRI; avoid endoscopy with air insufflation
Persistent cough, atypical chest pain	Infectious process, pulmonary vein stenosis	Physical exam, laboratory blood work, chest X-ray, chest CT or MRI
Neurological symptoms	Cerebral embolic event, atrial esophageal fistula	Physical exam, brain imaging, chest CT or MRI
Hemoptysis	PV stenosis or occlusion, pneumoma	CT scan, VQ scan

DEFINITIONS OF COMPLICATIONS

Table 8 Definitions of complications associated with AF ablation

Asymptomatic cerebral embolism	Asymptomatic cerebral embolism is defined as an occlusion of a blood vessel in the brain due to an embolus that does not result in any acute clinical symptoms. Silent cerebral embolism is generally detected using a diffusion weighted MRI.
Atrioesophageal fistula	An atrioesophageal fistula is defined as a connection between the atrium and the lumen of the esophagus. Evidence supporting this diagnosis includes documentation of esophageal erosion combined with evidence of a fistulous connection to the atrium, such as air emboli, an embolic event, or direct observation at the time of surgical repair. A CT scan or MRI scan is the most common method of documentation of an atrioesophageal fistula.
Bleeding	Bleeding is defined as a major complication of AF ablation if it requires and/or is treated with transfusion or results in a 20% or greater fall in hematocrit.
Bleeding following cardiac surgery	Excessive bleeding following a surgical AF ablation procedure is defined as bleeding requiring reoperation or ≥2 units of PRBC transfusion within any 24 hours of the first 7 days following the index procedure.
Cardiac perforation	We recommend that cardiac perforation be defined together with cardiac tamponade. See "Cardiac tamponade/perforation."
Cardiac tamponade	We recommend that cardiac tamponade be defined together with cardiac perforation. See "Cardiac tamponade/perforation."
Cardiac tamponade/perforation	Cardiac tamponade/perforation is defined as the development of a significant pericardial effusion during or within 30 days of undergoing an AF ablation procedure. A significant pericardial effusion is one that results in hemodynamic compromise, requires elective or urgent pericardiocentesis, or results in a 1-cm or more pericardial effusion as documented by echocardiography. Cardiac tamponade/perforation should also be classified as "early" or "late" depending on whether it is diagnosed during or following initial discharge from the hospital.
Deep sternal wound infection/mediastinitis following cardiac surgery	Deep sternal wound infection/mediastinitis following cardiac surgery requires one of the following: (1) an organism isolated from culture of mediastinal tissue or fluid; (2) evidence of mediastinitis observed during surgery; (3) one of the following conditions: chest pain, sternal instability, or fever (>38°C), in combination with either purulent discharge from the mediastinum or an organism isolated from blood culture or culture of mediastinal drainage.
Esophageal injury	Esophageal injury is defined as an erosion, ulceration, or perforation of the esophagus. The method of screening for esophageal injury should be specified. Esophageal injury can be a mild complication (erosion or ulceration) or a major complication (perforation).
Gastric motility/pyloric spasm disorders	Gastric motility/pyloric spasm disorder should be considered a major complication of AF ablation when it prolongs or requires hospitalization, requires intervention, or results in late disability, such as weight loss, early satiety, diarrhea, or GI disturbance.

If a patient has a history of typical atrial flutter or typical atrial flutter is induced at the time of AF ablation, delivery of a cavotricuspid isthmus linear lesion is recommended.	I	B-R
If linear ablation lesions are applied, operators should use mapping and pacing maneuvers to assess for line completeness.	I	C-LD
If a reproducible focal trigger that initiates AF is identified outside the PV ostia at the time of an AF ablation procedure, ablation of the focal trigger should be considered.	IIa	C-LD
When performing AF ablation with a force-sensing RF ablation catheter, a minimal targeted contact force of 5 to 10 grams is reasonable.	IIa	C-LD

Ablation strategies to be considered for use in conjunction with PV isolation

Posterior wall isolation might be considered for initial or repeat ablation of persistent or long-standing persistent AF.	IIb	C-LD
Administration of high-dose isoproterenol to screen for and then ablate non-PV triggers may be considered during initial or repeat AF ablation procedures in patients with paroxysmal, persistent, or long-standing persistent AF.	IIb	C-LD
DF-based ablation strategy is of unknown usefulness for AF ablation.	IIb	C-LD
The usefulness of creating linear ablation lesions in the right or left atrium as an initial or repeat ablation strategy for	IIb	B-NR
The usefulness of linear ablation lesions in the absence of macroreentrant atrial flutter is not well established.	IIb	C-LD
The usefulness of mapping and ablation of areas of abnormal myocardial tissue identified with voltage mapping or MRI as an initial or repeat ablation strategy for persistent or long-standing persistent AF is not well established.	IIb	B-R
The usefulness of ablation of complex fractionated atrial electrograms as an initial or repeat ablation strategy for persistent and long-standing persistent AF is not well established.	IIb	B-R
The usefulness of ablation of rotational activity as an initial or repeat ablation strategy for persistent and long-standing persistent AF is not well established.	IIb	B-NR
The usefulness of ablation of autonomic ganglia as an initial or repeat ablation strategy for paroxysmal, persistent, and long-standing persistent AF is not well established.	IIb	B-NR

Careful identification of the PV ostia is mandatory to avoid ablation within the PVs.	I	B-NR
It is recommended that RF power be reduced when creating lesions along the posterior wall near the esophagus.	I	C-LD
It is reasonable to use an esophageal temperature probe during AF ablation procedures to monitor esophageal temperature and help guide energy delivery.	IIa	C-EO

Table 5 Signs and symptoms following AF ablation

	Differential	Suggested evaluation
Signs and symptoms of complications within a month postablation		
Back pain	Musculoskeletal, retroperitoneal hematoma	Physical exam, CT imaging
Chest pain	Pericarditis, pericardial effusion, coronary stenosis (ablation related), pulmonary vein stenosis, musculoskeletal (after cardioversion), worsening reflux	Physical exam, chest X-ray, ECG, echocardiogram, stress test, cardiac catheterization, chest CT
Cough	Infectious process, bronchial irritation (mechanical, cryoballoon), pulmonary vein stenosis	Physical exam, chest X-ray, chest CT
Dysphagia	Esophageal irritation (related to transesophageal echocardiography), atrioesophageal fistula	Physical exam, chest CT or MRI
Early satiety, nausea	Gastric denervation	Physical exam, gastric emptying study
Fever	Infectious process, pericarditis, atrioesophageal fistula	Physical exam, chest X-ray, chest CT, urinalysis, laboratory blood work
Fever, dysphagia, neurological symptoms	Atrial esophageal fistula	Physical exam, laboratory blood work, chest CT or MRI; avoid endoscopy with air insufflation
Groin pain at site of access	Pseudoaneurysm, AV fistula, hematoma	Ultrasound of the groin, laboratory blood work; consider CT scan if ultrasound negative
Headache	Migraine (related to anesthesia or transseptal access, hemorrhagic stroke), effect of general anesthetic	Physical exam, brain imaging (MRI)
Hypotension	Pericardial effusion/tamponade, bleeding, sepsis, persistent vagal reaction	Echocardiography, laboratory blood work
Hemoptysis	PV stenosis or occlusion, pneumonia	Chest X-ray, chest CT or MR scan, VQ scan
Neurological symptoms	Cerebral embolic event, atrial esophageal fistula	Physical exam, brain imaging, chest CT or MRI
Shortness of breath	Volume overload, pneumoma, pulmonary vein stenosis, phrenic nerve injury	Physical exam, chest X-ray, chest CT, laboratory blood work
Signs and symptoms of complications more than a month postablation		
Fever, dysphagia, neurological symptoms	Atrial esophageal fistula	Physical exam, laboratory blood work, chest CT or MRI; avoid endoscopy with air insufflation
Persistent cough, atypical chest pain	Infectious process, pulmonary vein stenosis	Physical exam, laboratory blood work, chest X-ray, chest CT or MRI
Neurological symptoms	Cerebral embolic event, atrial esophageal fistula	Physical exam, brain imaging, chest CT or MRI
Hemoptysis	PV stenosis or occlusion, pneumonia	CT scan, VQ scan

Major complication	A major complication is a complication that results in permanent injury or death, requires intervention for treatment, or prolongs or requires hospitalization for more than 48 hours. Because early recurrences of AF/AFL/AT are to be expected following AF ablation, recurrent AF/AFL/AT within 3 months that requires or prolongs a patient's hospitalization should not be considered to be a major complication of AF ablation.
Mediastinitis	Mediastinitis is defined as inflammation of the mediastinum. Diagnosis requires one of the following: (1) an organism isolated from culture of mediastinal tissue or fluid; (2) evidence of mediastinitis observed during surgery; (3) one of the following conditions: chest pain, sternal instability, or fever (>38°C), in combination with either purulent discharge from the mediastinum or an organism isolated from blood culture or culture of mediastinal drainage.
Myocardial infarction in the context of AF ablation	The universal definition of myocardial infarction[1399] cannot be applied in the context of catheter or surgical AF ablation procedures because it relies heavily on cardiac biomarkers (troponin and CPK), which are anticipated to increase in all patients who undergo AF ablation as a result of the ablation of myocardial tissue. Similarly, chest pain and other cardiac symptoms are difficult to interpret in the context of AF ablation both because of the required sedation and anesthesia and also because most patients experience chest pain following the procedure as a result of the associated pericarditis that occurs following catheter ablation. We therefore propose that a myocardial infarction, in the context of catheter or surgical ablation, be defined as the presence of any one of the following criteria: (1) detection of ECG changes indicative of new ischemia (new ST-T wave changes or new LBBB) that persist for more than 1 hour; (2) development of new pathological Q waves on an ECG; (3) imaging evidence of new loss of viable myocardium or new regional wall motion abnormality.
Pericarditis	Pericarditis should be considered a major complication following ablation if it results in an effusion that leads to hemodynamic compromise or requires pericardiocentesis, prolongs hospitalization by more than 48 hours, requires hospitalization, or persists for more than 30 days following the ablation procedure.
Phrenic nerve paralysis	Phrenic nerve paralysis is defined as absent phrenic nerve function as assessed by a sniff test. A phrenic nerve paralysis is considered to be permanent when it is documented to be present 12 months or longer following ablation.
Pulmonary vein stenosis	Pulmonary vein stenosis is defined as a reduction of the diameter of a PV or PV branch. PV stenosis can be categorized as mild <50%, moderate 50%–70%, and severe ≥70% reduction in the diameter of the PV or PV branch. A severe PV stenosis should be considered a major complication of AF ablation.
Serious adverse device effect	A serious adverse device effect is defined as a serious adverse event that is attributed to use of a particular device
Stiff left atrial syndrome	Stiff left atrial syndrome is a clinical syndrome defined by the presence of signs of right heart failure in the presence of preserved LV function, pulmonary hypertension (mean PA pressure >25 mm Hg or during exercise >30 mm Hg), and large V waves ≥10 mm Hg or higher) on PCWP or left atrial pressure tracings in the absence of significant mitral valve disease or PV stenosis.