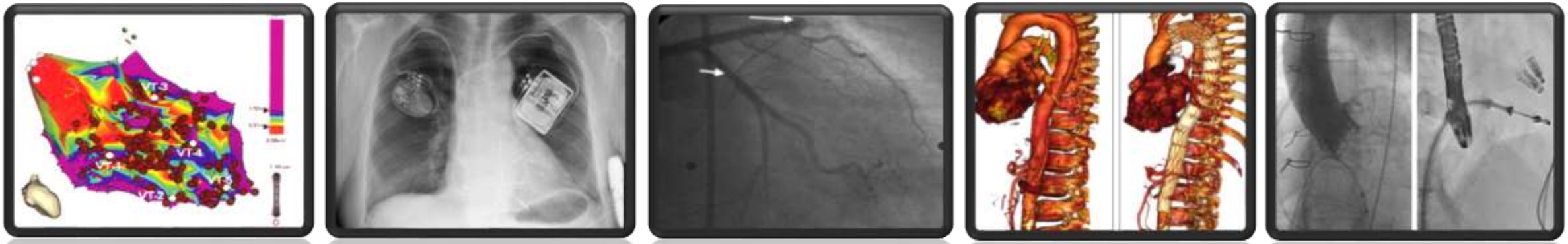
Atrial Fibrillation



Diaspora Health Week 2026
Nigeria Medical Association Germany
21.01.2026
Mannheim

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I, *Ibrahim Akin* DO NOT have a financial interest / arrangement or affiliation with one or more organizations that could be perceived as a real or apparent conflict of interest in the context of the subject of this presentation.

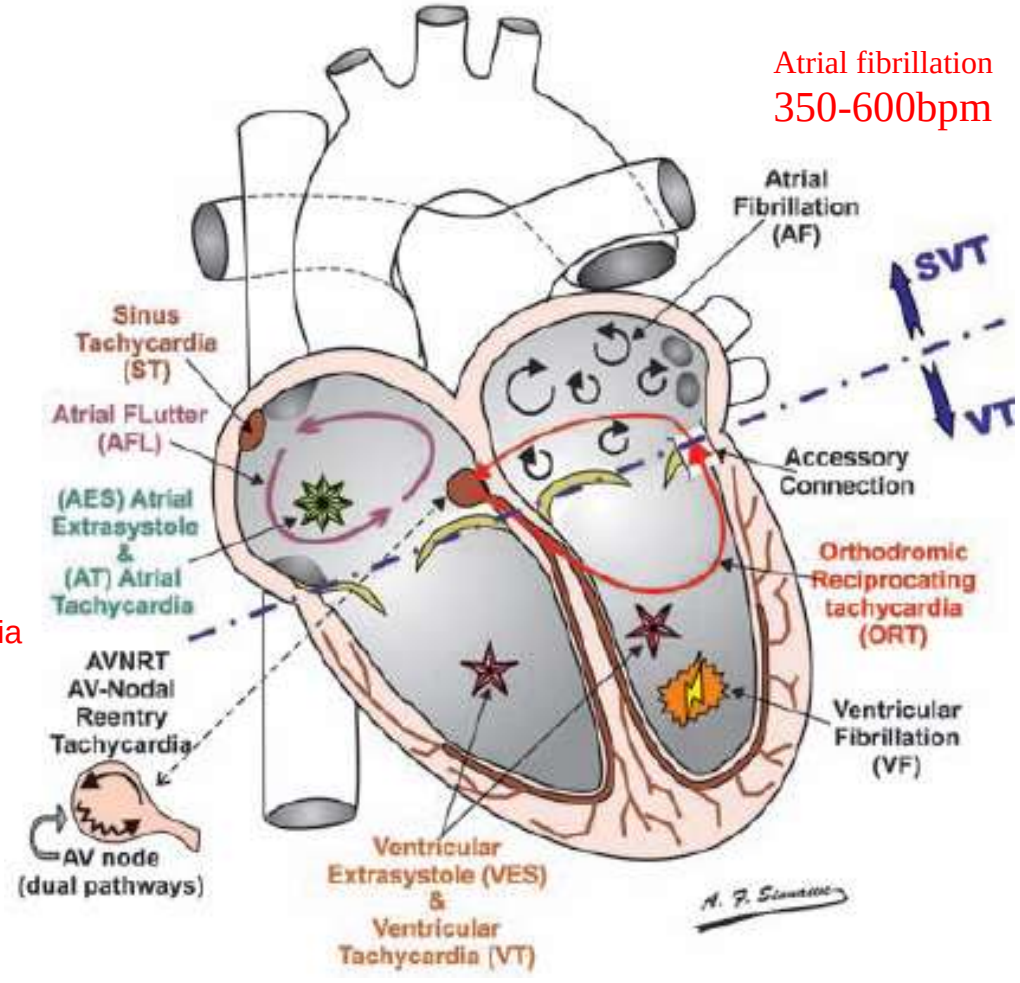
Rhythm Disorders

Atrial fibrillation
350-600bpm

Atrial flutter
250-350bpm

Atrial Tachycardia
120-250bpm

AV-nodal Reentrytachycardia
140-180bpm



WPW
meist > 180/min

Ventrikular tachycardia
> 100bpm, mostly 150-200bpm
Ventricular flutter
250-300bpm
Ventricular fibrillation
> 300bpm

Atrial Fibrillation – ESC Guidelines

1492
References

ESC European Society of Cardiology
European Heart Journal (2020) 00, 1–125
doi:10.1093/eurheartj/ehaa612

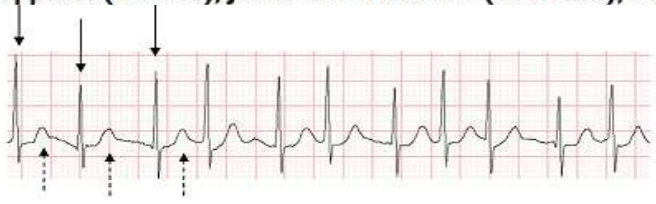
ESC GUIDELINES

2020 ESC Guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association of Cardio-Thoracic Surgery (EACTS)

The Task Force for the diagnosis and management of atrial fibrillation of the European Society of Cardiology (ESC)

Developed with the special contribution of the European Heart Rhythm Association (EHRA) of the ESC

Authors/Task Force Members: Gerhard Hindricks* (Chairperson) (Germany), Tatjana Potpara* (Chairperson) (Serbia), Nikolaos Dagres (Germany), Elena Arbelo (Spain), Jeroen J. Bax (Netherlands), Carina Blomström-Lundqvist (Sweden), Giuseppe Boriani (Italy), Manuel Castella[1] (Spain), Gheorghe-Andrei Dan (Romania), Polychronis E. Dilaveris (Greece), Laurent Fauchier (France), Gerasimos Filippatos (Greece), Jonathan M. Kalman (Australia), Mark La Meir[1]



Definition

Table 1
Clinical concepts and definitions of AHRE, device-detected SCAF and clinical AF.

Clinical concept	Definition	Clinical differences	
AHRE	Episode generally lasting more than 5 min with an atrial rate ≥ 170 bpm* detected by CIEDs allowing for automated continuous monitoring and storage of atrial rhythm. A visual inspection of intracardiac EGMs by professional is needed.	Asymptomatic patients without previously detected clinical AF on a surface ECG.	• Rate criterion: ≥170 bpm*. • Duration criterion: usually ≥5 min.
Device-detected SCAF	Asymptomatic episode of AF detected by CIEDs or consumer-based wearable monitors. A visual inspection of intracardiac EGMs or ECG-recorded rhythm is needed.		• Rate criterion: no specific rate limit. • Duration criterion: wide range cut-offs (mainly from 10 to 20 s to >24 h).
Clinical AF	Symptomatic or asymptomatic AF documented by surface ECG (12-lead ECG or other ECG devices). The minimum duration of 30 s indicate a clinical need for further monitoring or risk stratification for thromboembolism.	Symptomatic or asymptomatic patients with AF documented by surface ECG.	

Note: Although not completely identical, the terms AHRE, device-detected SCAF and SCAF are often used interchangeably.
* ≥ 170 bpm according to 2024 European guidelines on atrial fibrillation; * ≥ 190 bpm according to 2017 European Heart Rhythm Association.
AF = atrial fibrillation; AHREs = atrial high-rate episodes; CIEDs = implanted cardiac electronic devices; EGMs = electrograms; SCAF = subclinical atrial fibrillation.

Gelder IC, et al. Eur Heart J 2024

Atrial Fibrillation - Categorization

AF pattern	Definition
First diagnosed	AF not diagnosed before, irrespective of its duration or the presence/severity of AF-related symptoms.
Paroxysmal	AF that terminates spontaneously or with intervention within 7 days of onset.
Persistent	AF that is continuously sustained beyond 7 days, including episodes terminated by cardioversion (drugs or electrical cardioversion) after ≥7 days
Long-standing persistent	Continuous AF of >12 months' duration when decided to adopt a rhythm control strategy.
Permanent	AF that is accepted by the patient and physician, and no further attempts to restore/maintain sinus rhythm will be undertaken. Permanent AF represents a therapeutic attitude of the patient and physician rather than an inherent pathophysiological attribute of AF, and the term should not be used in the context of a rhythm control strategy with antiarrhythmic drug therapy or AF ablation. Should a rhythm control strategy be adopted, the arrhythmia would be re-classified as 'long-standing persistent AF'.
Terminology that should be abandoned	
Lone AF	A historical descriptor. Increasing knowledge about the pathophysiology of AF shows that in every patient a cause is present. Hence, this term is potentially confusing and should be abandoned.[147]
Valvular/non-valvular AF	Differentiates patients with moderate/severe mitral stenosis and those with mechanical prosthetic heart valve(s) from other patients with AF, but may be confusing[148] and should not be used.
Chronic AF	Has variable definitions and should not be used to describe populations of AF patients.

Hindricks G, et al Eur Heart J 2021;42:373-498

Atrial Fibrillation – Global Prevalence

Hindricks G, et al Eur Heart J 2021;42:373-498

Atrial Fibrillation - Epidemiology

Figure 2. Prevalence of Diagnosed Atrial Fibrillation Stratified by Age and Sex

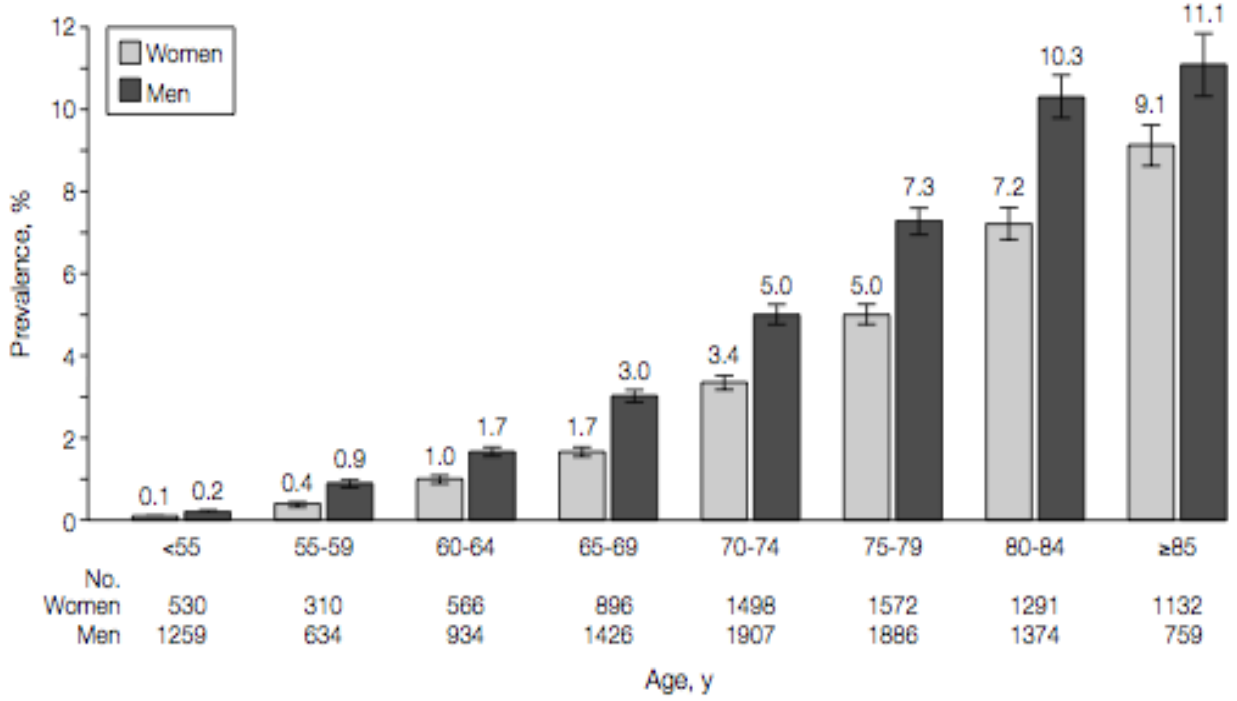
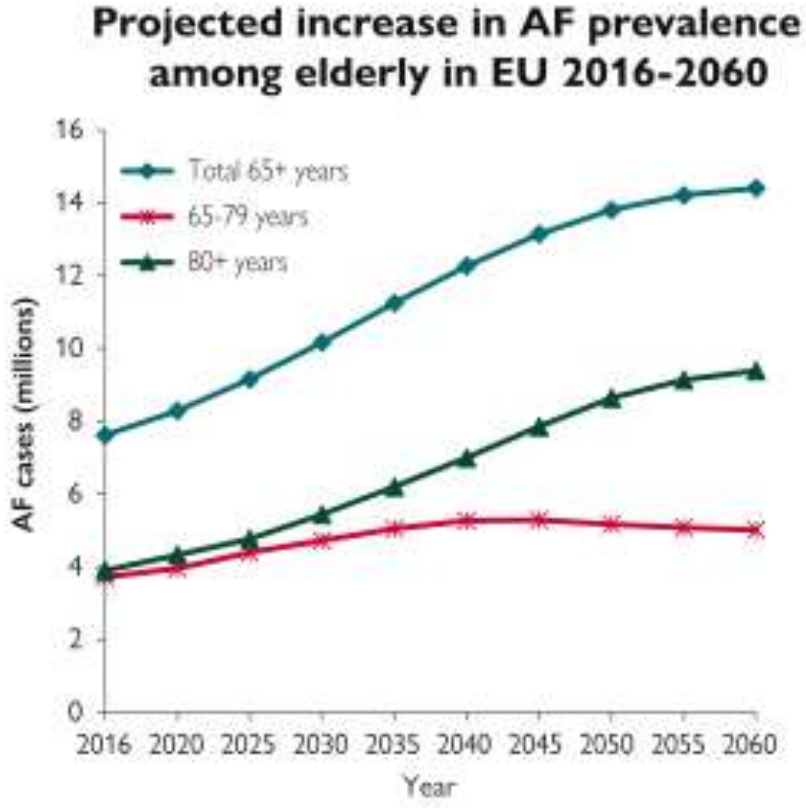


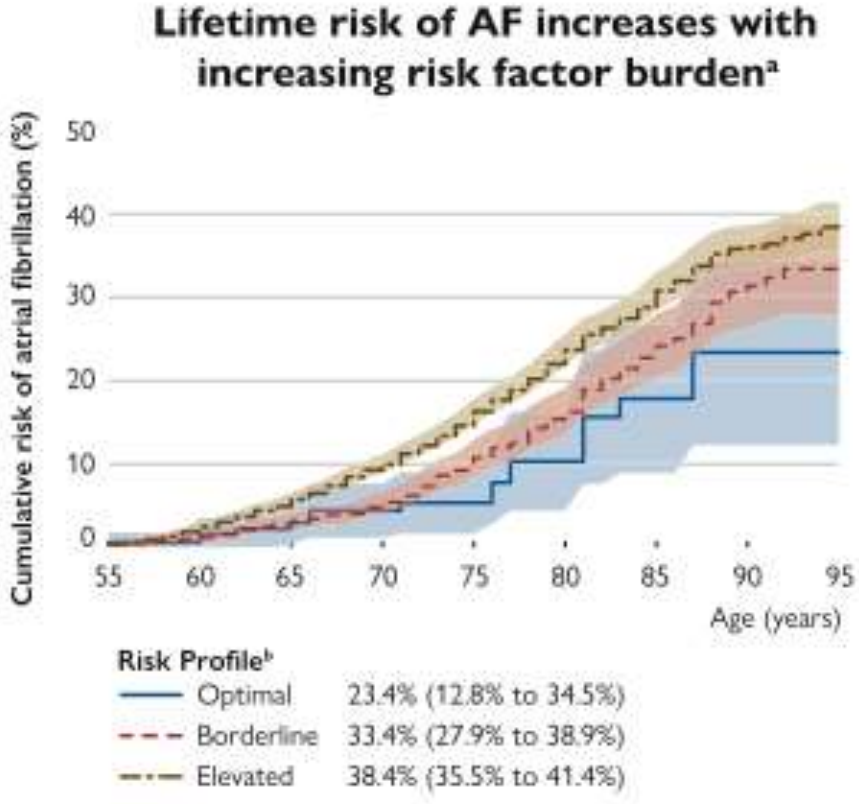
Table 1. Baseline Characteristics of 17 974 Adults With Diagnosed Atrial Fibrillation, July 1, 1996-December 31, 1997*

Characteristic	ATRIA Cohort (n = 17 974)
Age, mean (SD), y	71.2 (12.2)
≥80 y	25.4
Women	43.4
Race†	
White	84.7
Black	3.6
Hispanic or Latino	2.5
Other or multiple	9.1
Known valvular heart disease	4.9
Previous ischemic stroke	8.9
Diagnosed heart failure	29.2
Hypertension	49.3
Diabetes mellitus	17.1
Previous coronary heart disease	34.6
Angina	21.8
Myocardial infarction	9.4

Lgo AS, et al. JAMA 2001;285:2370-5
Fuster V, et al. Circulation 2006:114:257-354

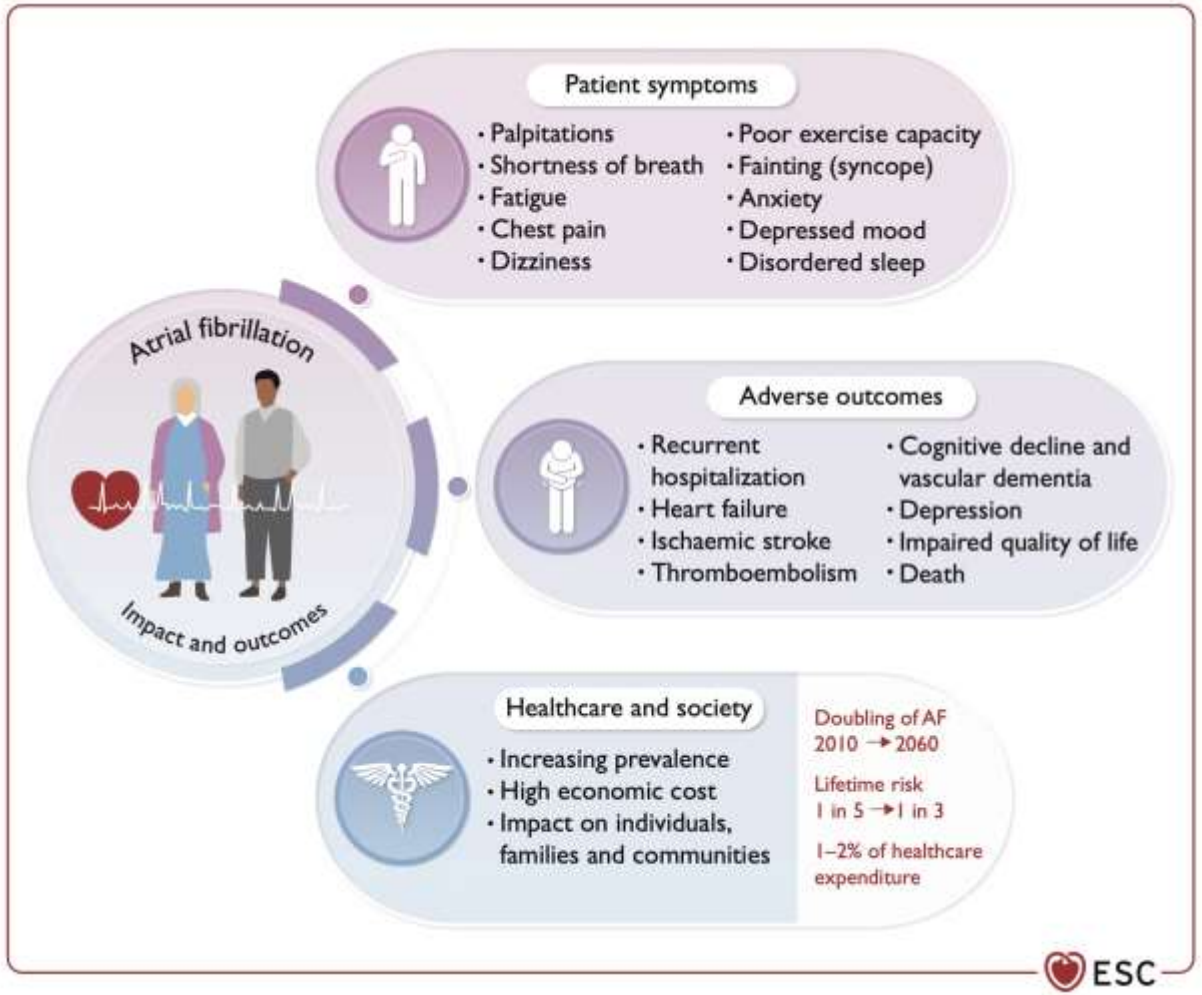
Atrial Fibrillation - Epidemiology





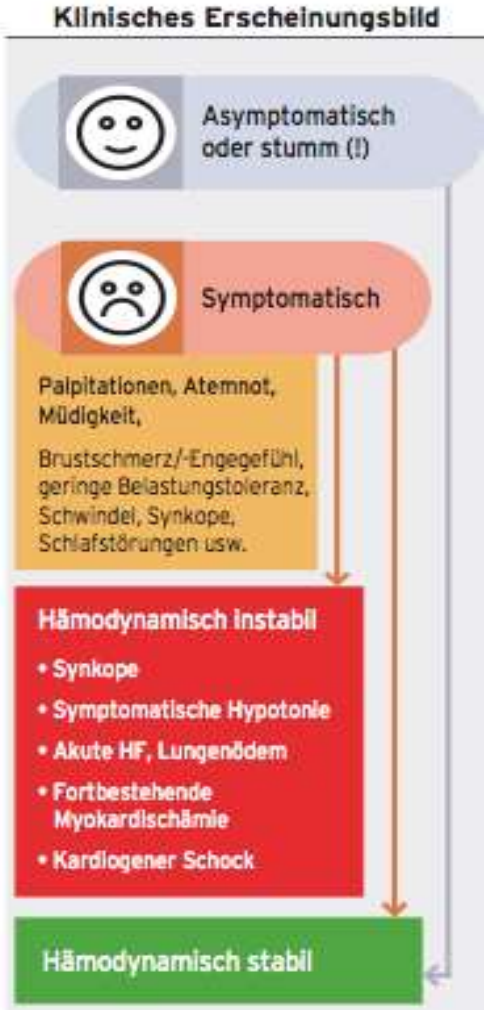
Hindricks G, et al Eur Heart J 2021;42:373-498

Guidelines – Clinical Impact



Van Gelder IC, et al. Eur Heart J 2024

Atrial Fibrillation - Prognosis

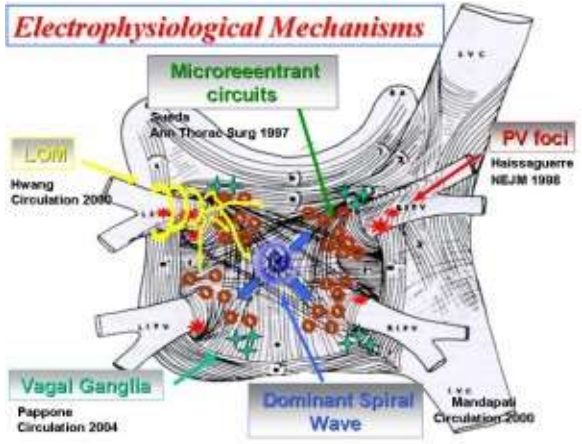


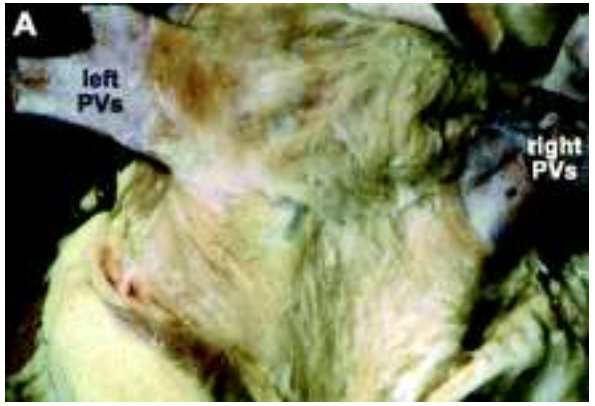
AF-bedingtes Ereignis	Häufigkeit bei AF	Mechanismen)
Tod	1,5- bis 3,5-fach erhöht	Übersterblichkeit in Zusammenhang mit: • HF, Begleit-erkrankungen • Schlaganfall
Schlaganfall	20-30 % aller ischämischen Schlaganfälle, 10 % der kryptogenen Schlaganfälle	• kardioembolisch oder • verbunden mit einer begleitenden atheromatösen Plaque
LV-Dysfunktion/ Herzinsuffizienz	bei 20-30 % aller AF-Patienten	• Überhöhte Kammerfrequenz • Unregelmäßige Kammer-kontraktionen • Eine Primärursache für das AF

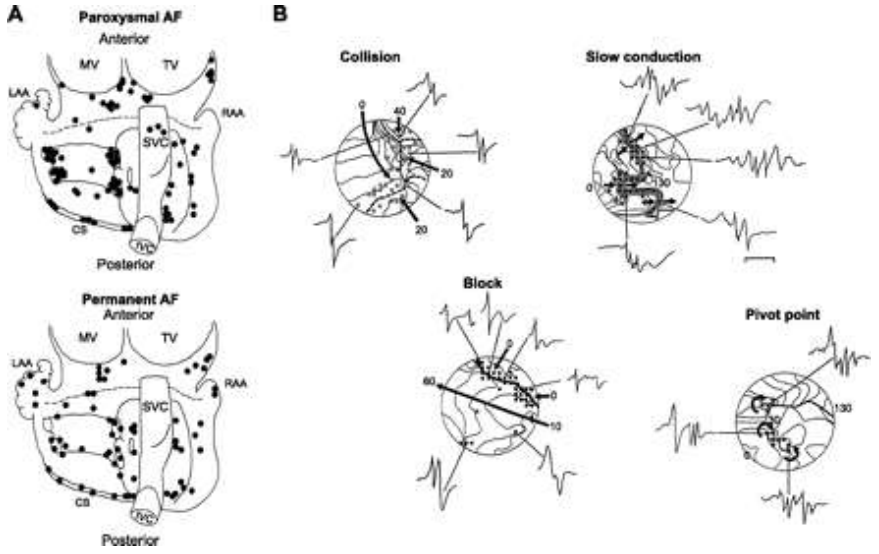
Kognitiver Verfall/ Vaskuläre Demenz	HR 1,4/1,6 (unabhängig von Schlag-anfall-anamnese)	• Läsion der weißen Substanz, Entzündung • Hypoperfusion • Mikroembolien
Depression	Depression bei 16-20 % (sogar suizidale Gedanken)	• Schwere Symptomatik und verminderte QoL • Medikamenten-Nebenwirkungen
Beeinträchtigte Lebensqualität	> 60 % der Patienten	• bedingt durch AF-Last, Begleiterkrankungen, psychologische Belastungen und Pharmakotherapie • Gestresster Persönlichkeitstyp
Krankenhaus-aufenthalte	10-40 % Hospi-talisierungsrate pro Jahr	• AF-Behandlung, in Zusammenhang mit HF, MI oder AF-bedingten Symptomen • Therapie-bedingte Komplikationen

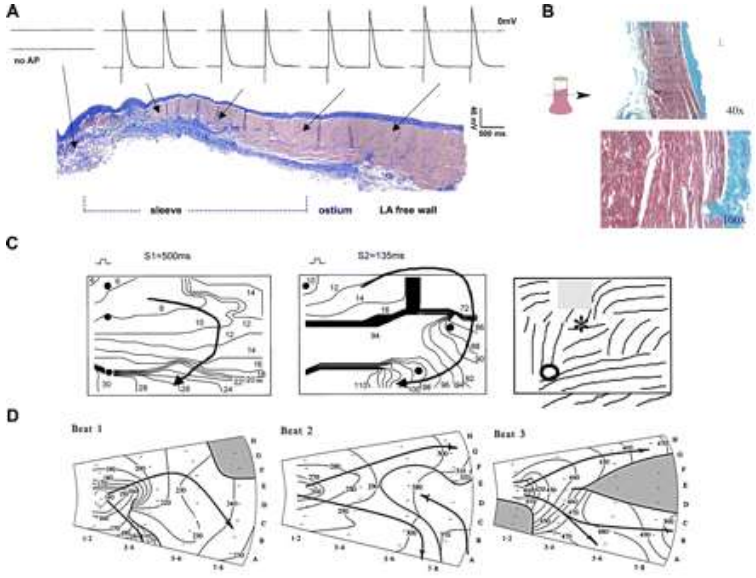
Hindricks G, et al Eur Heart J 2021;42:373-498

Atrial Fibrillation - Pathogenesis

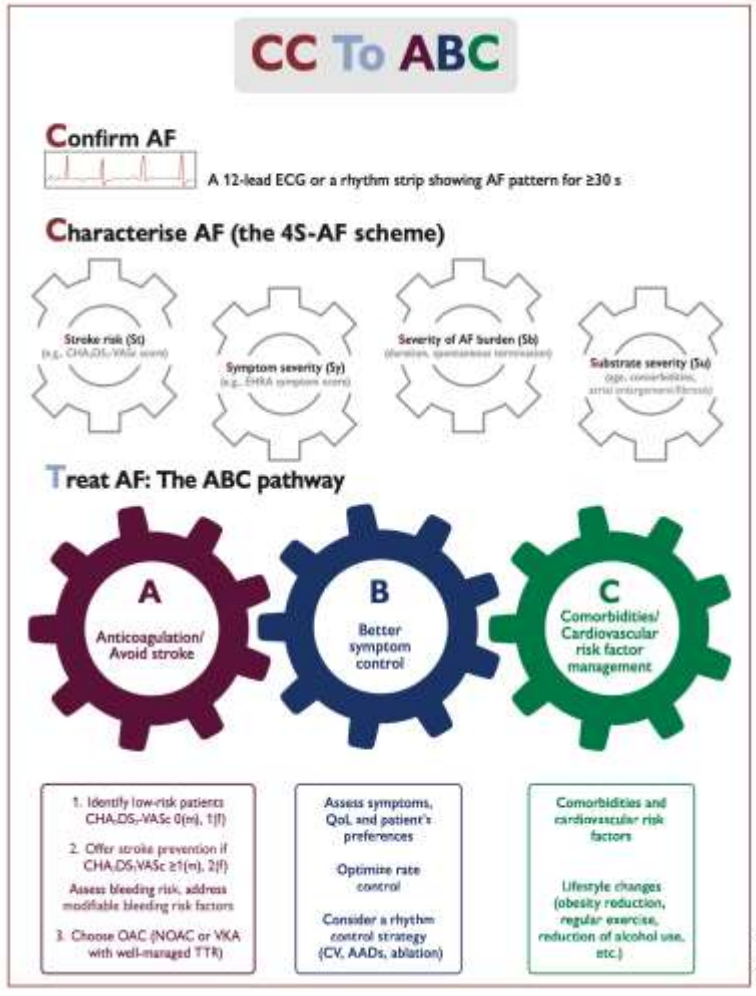


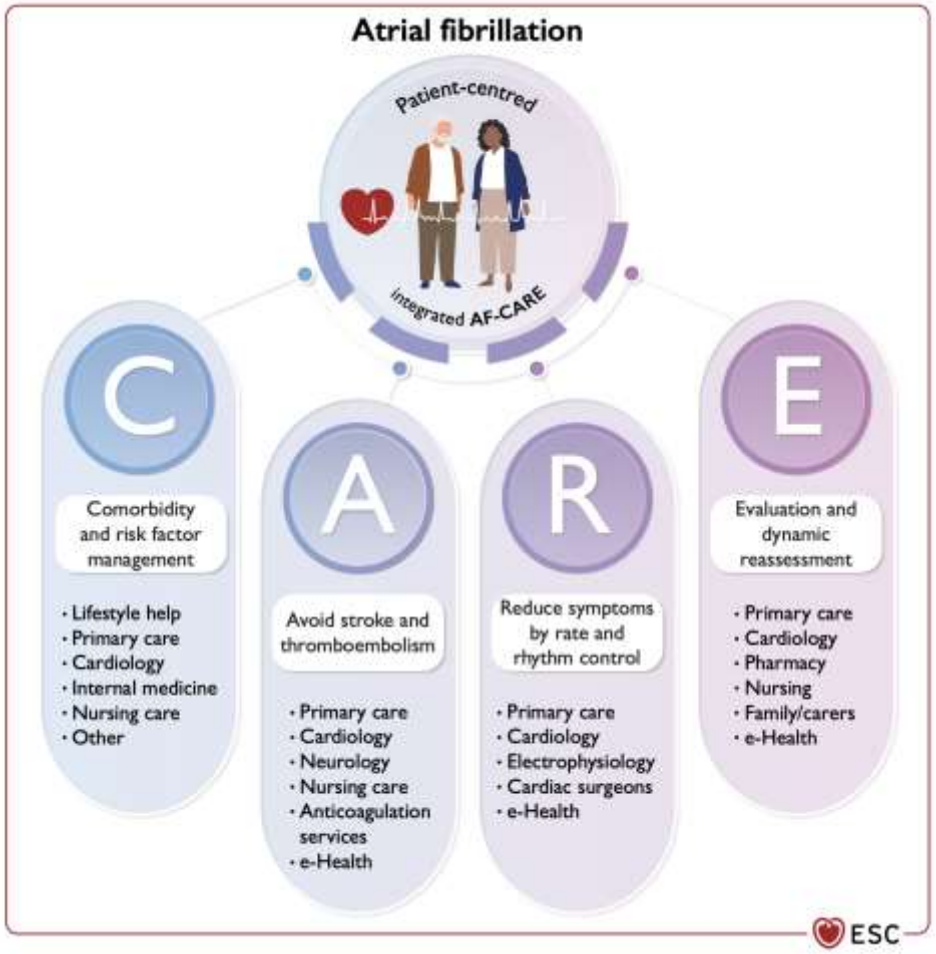






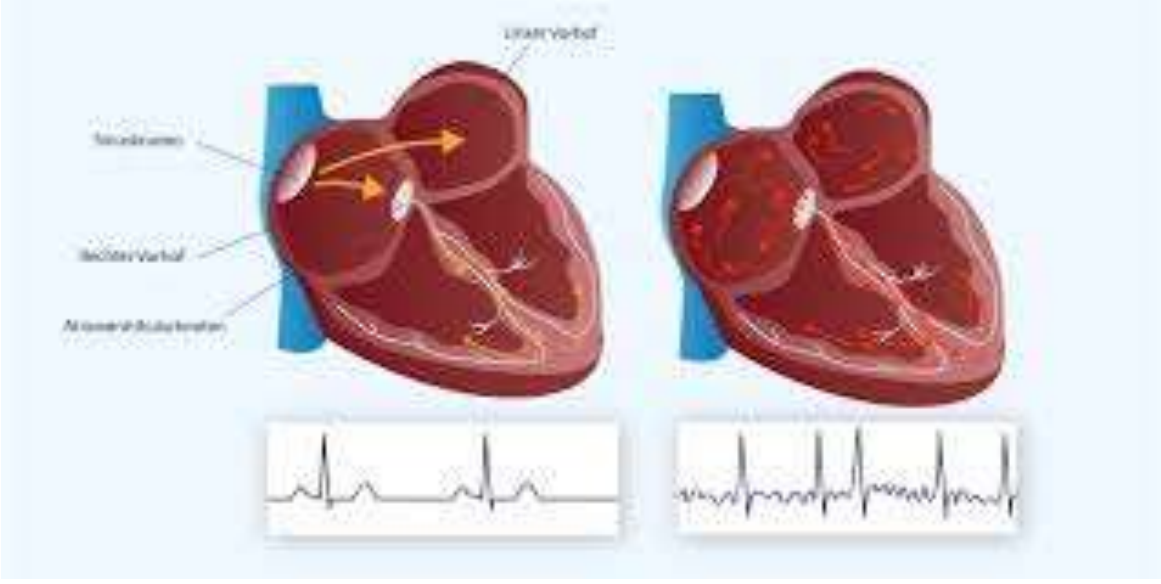
Atrial Fibrillation – ESC Guidelines

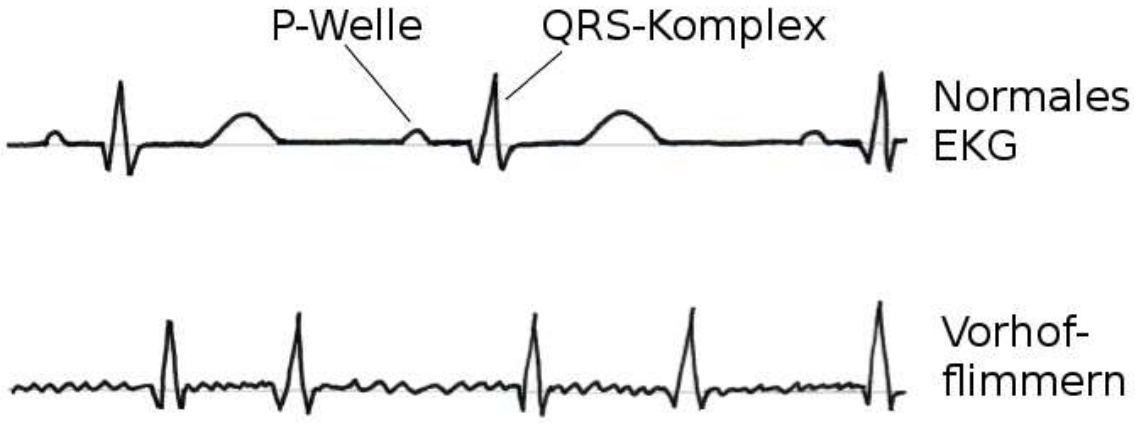




Hindricks G, et al Eur Heart J 2021
Gelder IC, et al. Eur Heart J 2024

Atrial Fibrillation – Diagnosis

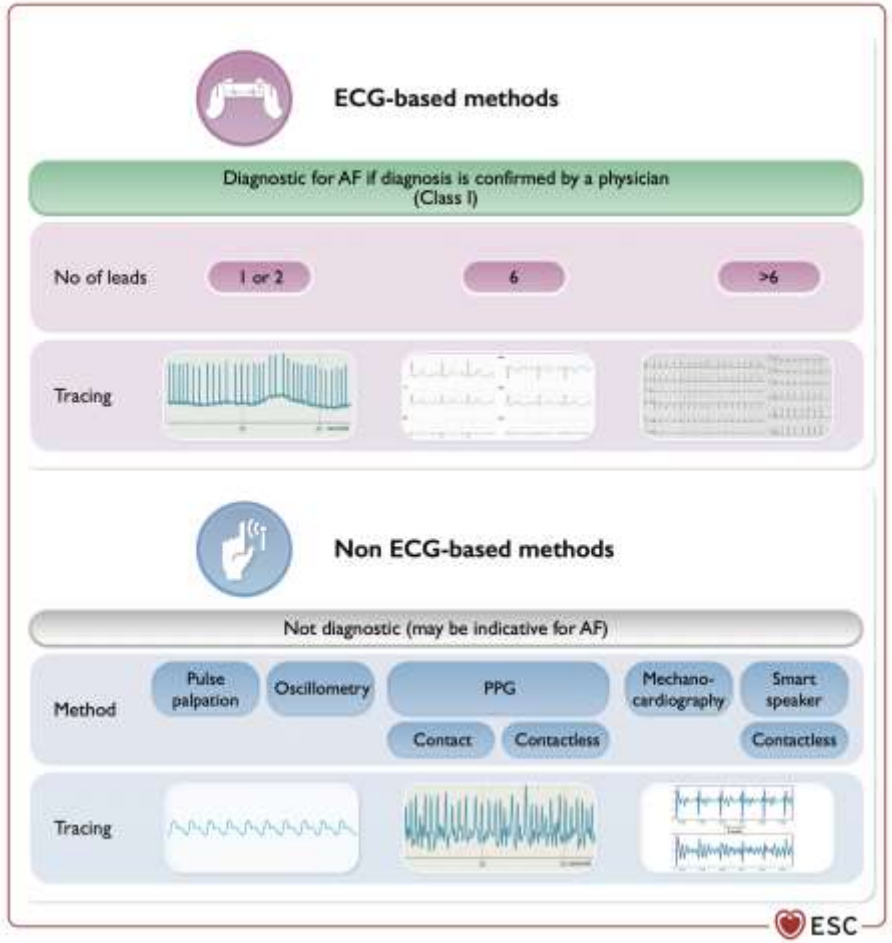




Clinical AF	Symptomatic or asymptomatic AF documented by surface ECG (12-lead ECG or other ECG devices). The minimum duration of 30 s indicate a clinical need for further monitoring or risk stratification for thromboembolism.	Symptomatic or asymptomatic patients with AF documented by surface ECG.

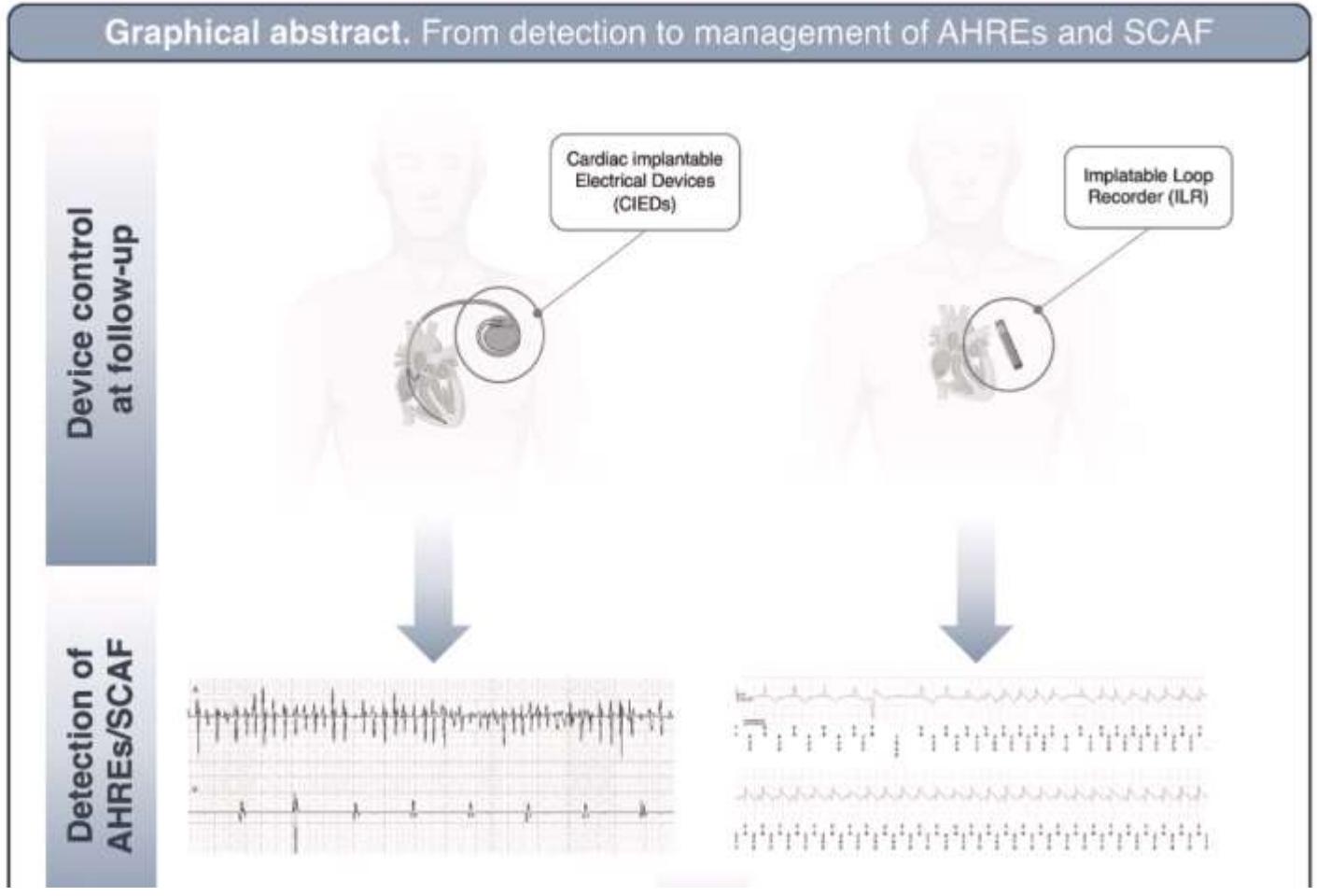
Hindricks G, et al Eur Heart J 2021;42:373-498

Atrial Fibrillation – Diagnosis



Hindricks G, et al Eur Heart J 2021;42:373-498

AHRE – SCAF Definition



Gelder IC, et al. Eur Heart J 2024

AHRE – Review

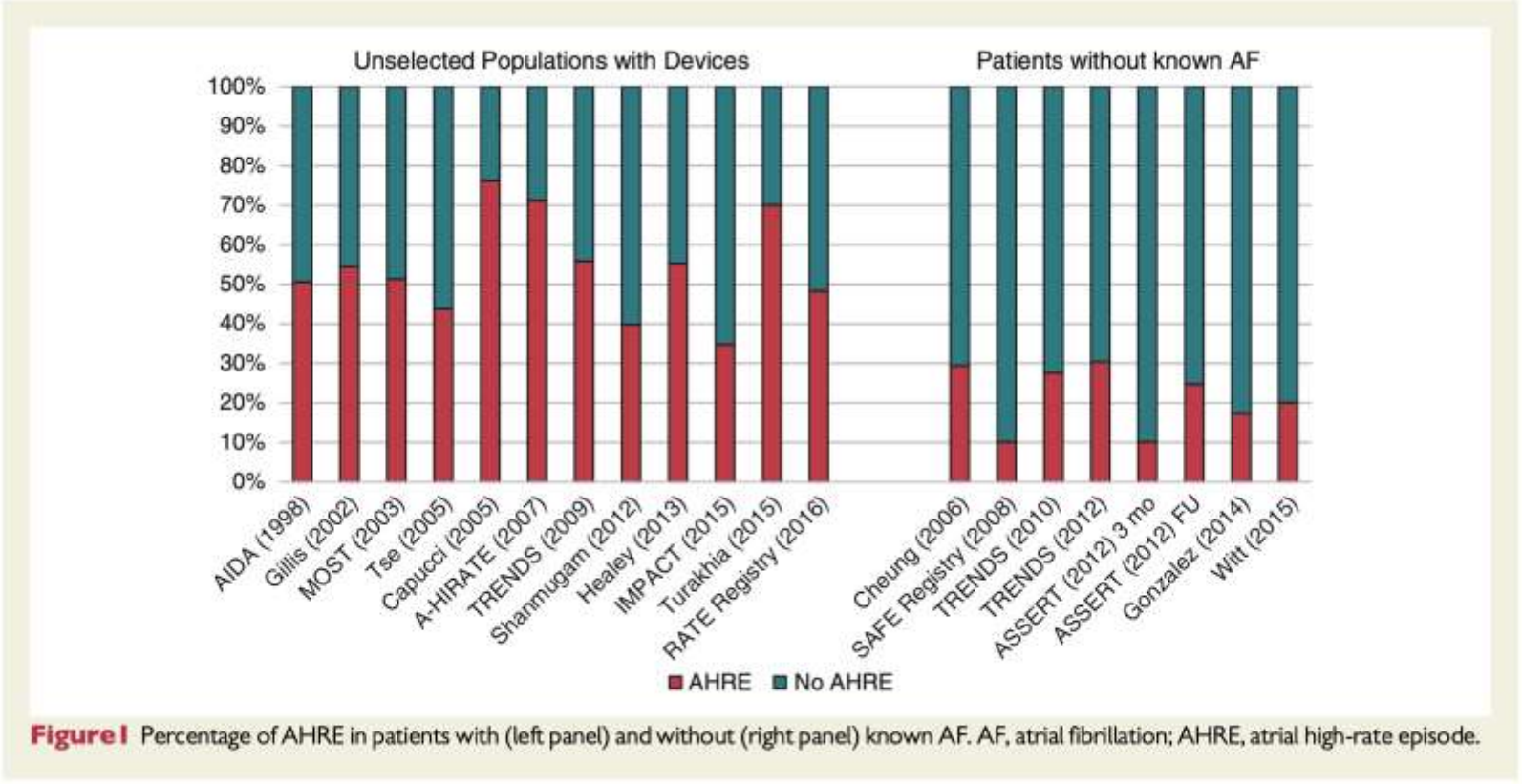


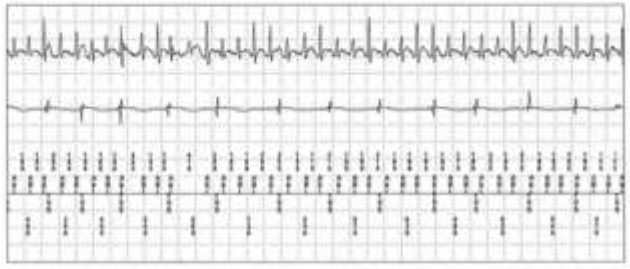
Figure 1 Percentage of AHRE in patients with (left panel) and without (right panel) known AF. AF, atrial fibrillation; AHRE, atrial high-rate episode.

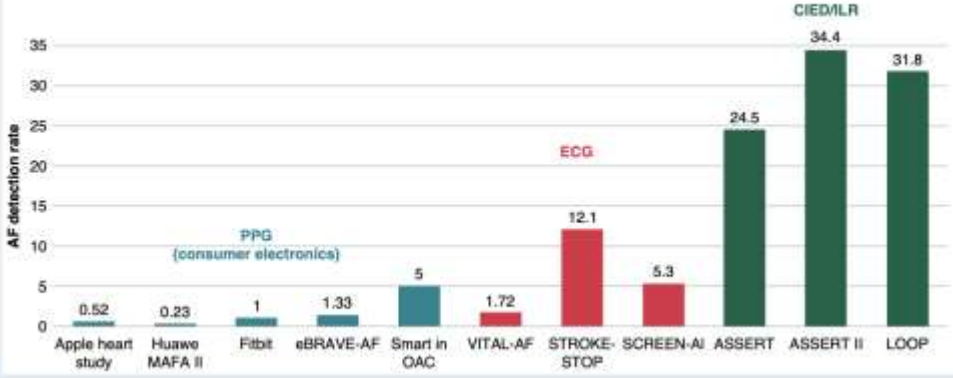
Bertaglia E, et al. Europace 2019;21:1459-67

AHRE – Review

Graphical Abstract

1. Atrial High Rate Episodes are found in 10 – 30% of persons with cardiovascular diseases, often without ECG-documented atrial fibrillation .





2. It remains unclear whether oral anticoagulation does more good or more harm in patients with AHRE.

Should patients with documented atrial high rate episodes receive oral anticoagulation?

Pro:
Risk of stroke or systemic embolism

Contra:
Risk of bleeding

Await results of NOAH AFNET6 and ARTESiA!
In patients at very high risk of systemic embolism, anticoagulation could be used if there is no increased risk of bleeding and clinical benefit can be anticipated.

Toennis T, et al. Europace 2023;25:1-10

AHRE – Review

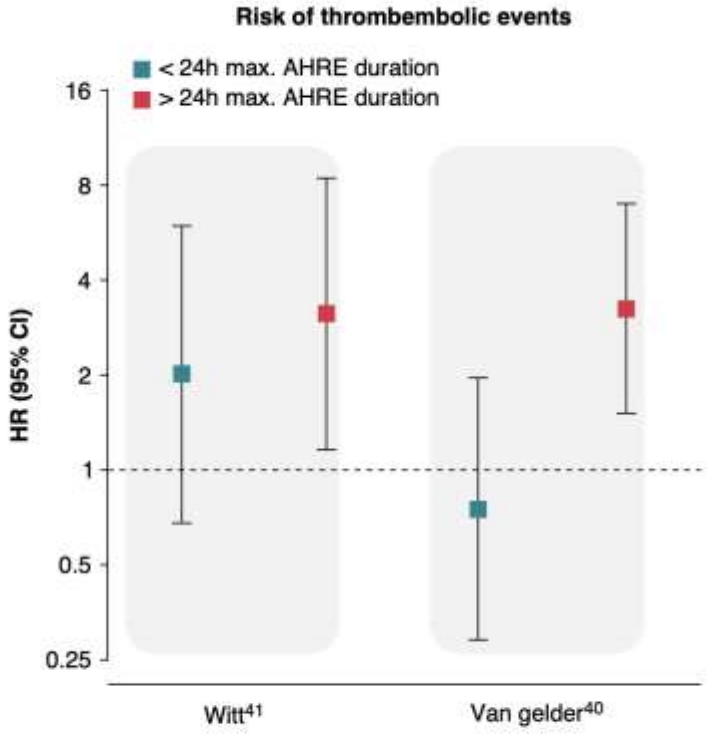


Figure 3 Hazard ratio for risk of thrombo-embolic event in patients with AHRE compared with patients without AHRE according to the longest duration of AHRE adapted from the observational studies by Witt *et al.* and van Gelder *et al.* (please see references). AHRE, atrial high-rate episode.

Toennis T, et al. Europace 2023;25:1-10

AHRE – ARTESIA

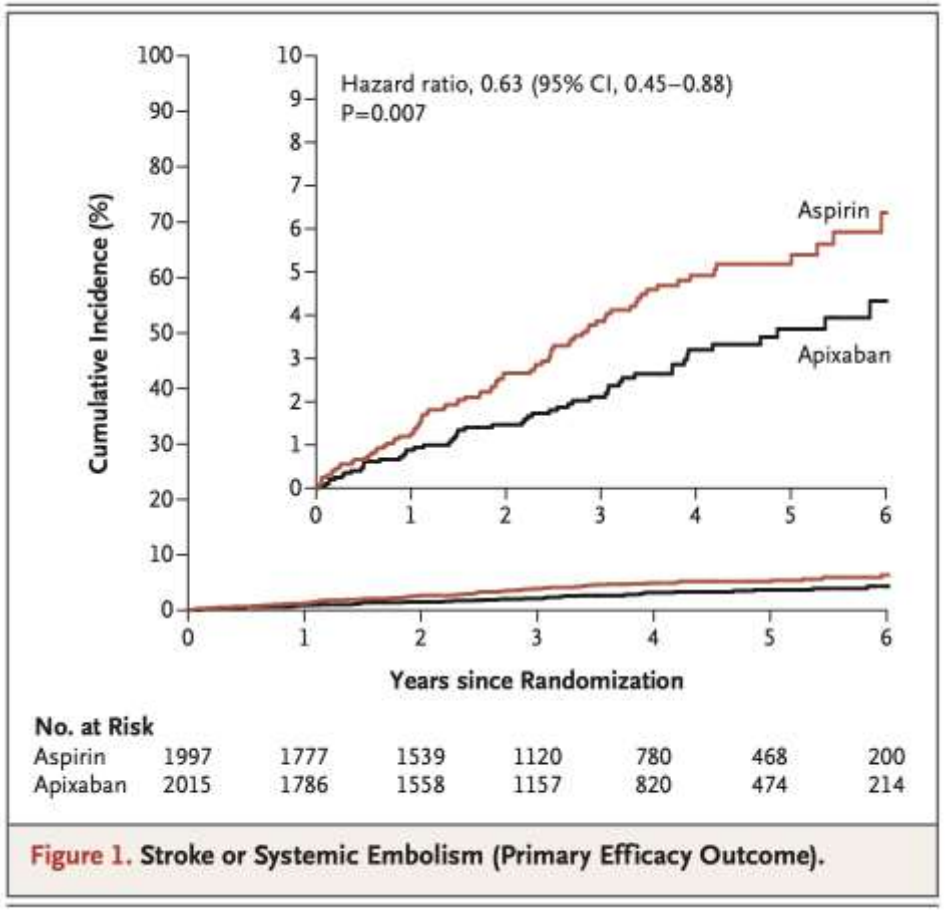


Figure 1. Stroke or Systemic Embolism (Primary Efficacy Outcome).

Table 2. Clinical Outcomes (Intention-to-Treat Population).*

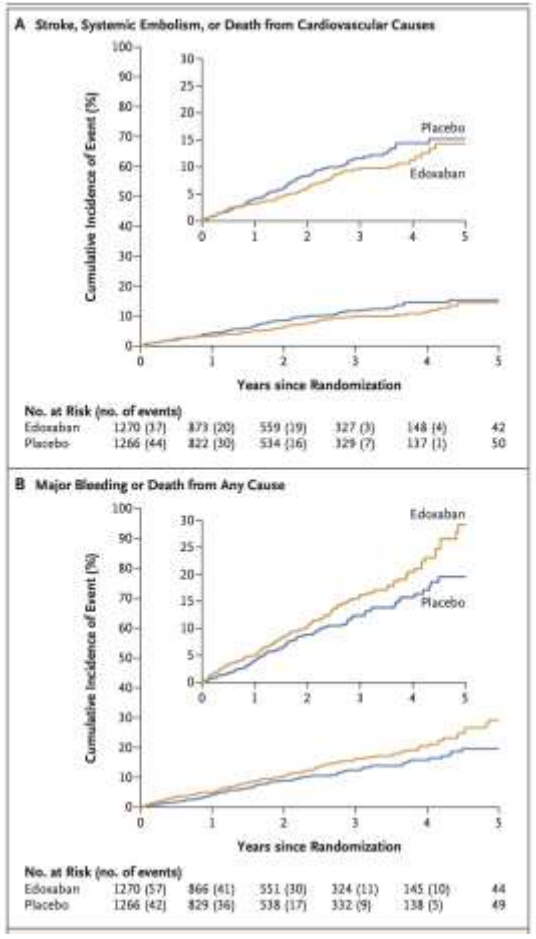
Outcome	Apixaban (N=2015)		Aspirin (N=1997)		Hazard Ratio (95% CI)	P Value
	no. of patients with event	*%/patient-yr*	*no. of patients with event*	*%/patient-yr*		
Stroke or systemic embolism	55	0.78	86	1.24	0.63 (0.45–0.88)	0.007
Stroke	55	0.78	84	1.21	0.64 (0.46–0.90)	
Ischemic or unknown type†	45	0.64	71	1.02	0.62 (0.43–0.91)	
Hemorrhagic	10	0.14	13	0.18	0.76 (0.33–1.73)	
Severity according to score on modified Rankin scale‡						
0–2	31	0.44	45	0.65	0.68 (0.43–1.07)	
3–6	19	0.27	37	0.53	0.51 (0.29–0.88)	
Missing data	5	0.07	2	0.03	2.48 (0.48–12.80)	
Systemic embolism	0		2	0.03	NA	
Stroke, TIA, or systemic embolism§	82	1.17	107	1.56	0.75 (0.56–1.00)	
Stroke, systemic embolism, or death from cardiovascular causes	148	2.10	171	2.47	0.85 (0.68–1.06)	
Stroke, myocardial infarction, systemic embolism, or death	419	6.01	418	6.10	0.98 (0.86–1.12)	
Myocardial infarction	37	0.52	41	0.59	0.89 (0.57–1.40)	
Death	362	5.06	341	4.82	1.04 (0.90–1.21)	
Death from cardiovascular causes	105	1.47	108	1.53	0.96 (0.73–1.25)	
Major bleeding¶	106	1.53	78	1.12	1.36 (1.01–1.82)	0.04
Fatal bleeding	10	0.14	14	0.20	0.70 (0.31–1.57)	
Symptomatic intracranial hemorrhage	17	0.24	23	0.33	0.73 (0.39–1.36)	
Gastrointestinal bleeding	55	0.78	31	0.44	1.76 (1.13–2.74)	
Transfusion performed	35	0.49	31	0.44	1.11 (0.68–1.80)	

Healey JS, et al. NEJM 2024;390:107-17

AHRE – NOAH AF Net

Table 2. Efficacy Outcomes.*

Outcome	Edoxaban (N=1270)	Placebo (N=1266)	Adjusted Hazard Ratio (95% CI)
	no. of patients with event/patient-yr (% per patient-yr)		
Primary composite efficacy outcome†	83/2557 (3.2)	101/2495 (4.0)	0.81 (0.60 to 1.08)‡
Ischemic stroke	22/2573 (0.9)	27/2519 (1.1)	0.79 (0.45 to 1.39)
Systemic embolism	14/2579 (0.5)	28/2515 (1.1)	0.51 (0.27 to 0.96)
Myocardial infarction	10/2589 (0.4)	16/2524 (0.6)	—
Pulmonary embolism	3/2589 (0.1)	9/2533 (0.4)	—
Peripheral limb embolism	1/2592 (<0.1)	3/2536 (0.1)	—
Abdominal embolism	0	1/2540 (<0.1)	—
Cardiovascular death	52/2595 (2.0)	57/2540 (2.2)	0.90 (0.62 to 1.31)
Death due to acute myocardial infarction	1/2595 (<0.1)	4/2540 (0.2)	—
Sudden cardiac death	18/2595 (0.7)	13/2540 (0.5)	—
Death due to heart failure	13/2595 (0.5)	15/2540 (0.6)	—
Death due to stroke	1/2595 (<0.1)	3/2540 (0.1)	—
Death due to cardiovascular hemorrhage	2/2595 (0.1)	1/2540 (<0.1)	—
Death due to other cardiovascular cause	1/2595 (<0.1)	4/2540 (0.2)	—
Death of unknown cause, counted as cardiovascular cause	16/2595 (0.6)	17/2540 (0.7)	—
Major adverse cardiovascular event§	92/2532 (3.6)	102/2485 (4.1)	0.89 (0.67 to 1.18)
Ischemic stroke or systemic embolism	25/2566 (1.0)	38/2509 (1.5)	0.65 (0.39 to 1.07)



Kirchhof P, et al. NEJM 2023;389:1167-79

AHRE – Anticoagulation NOAH AF-Net 6

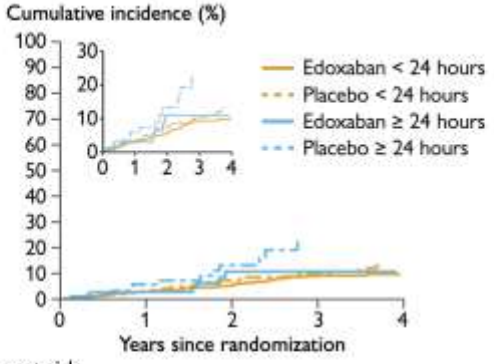
Anticoagulation in patients with long Atrial High-Rate Episodes (AHRE) ≥ 24 hours

A subanalysis of the Non-vitamin K antagonist Oral anticoagulation in patients with Atrial High rate episodes (NOAH-AFNET 6) trial

259/2389 patients with device-detected AHRE ≥24 hours
(78 years old, 28% women, median CHA_2DS_2-VASc score 4)

AHRE reviewed by Corelab

Incidence of stroke, systemic embolism, or cardiovascular death



Number at risk

< 24 hours					
Edoxaban	1062	748	497	292	134
Placebo	1067	709	464	289	126
≥ 24 hours					
Edoxaban	132	83	36	19	8
Placebo	127	71	41	21	8

Ischaemic stroke rate by AHRE duration and treatment*

AHRE < 24 hours events/N (%/patient-years)			AHRE ≥ 24 hours events/N (%/patient-years)		
Edoxaban	Placebo	HR (95% CI)	Edoxaban	Placebo	HR (95% CI)
20/1062 (0.90)	21/1068 (0.96)	0.92 (0.50, 1.70)	2/132 (0.95)	2/127 (0.97)	1.03 (0.14, 7.32)

*p-interaction=0.89

- Long durations of device-detected AHRE, including durations ≥24 hours, did not interact with the treatment effect of anticoagulation in the NOAH-AFNET 6 trial.
- Similarly, there was no interaction between the effect of anticoagulation therapy and AHRE duration used as a continuous variable.
- Stroke rate appeared low (1%/patient-year) without oral anticoagulation.
- Patients with AHRE ≥24 hours developed more ECG-diagnosed atrial fibrillation over time compared to those with shorter AHRE durations.

Becher N, et al. Eur Heart J 2024;45:837-49

AHRE – Recommendation

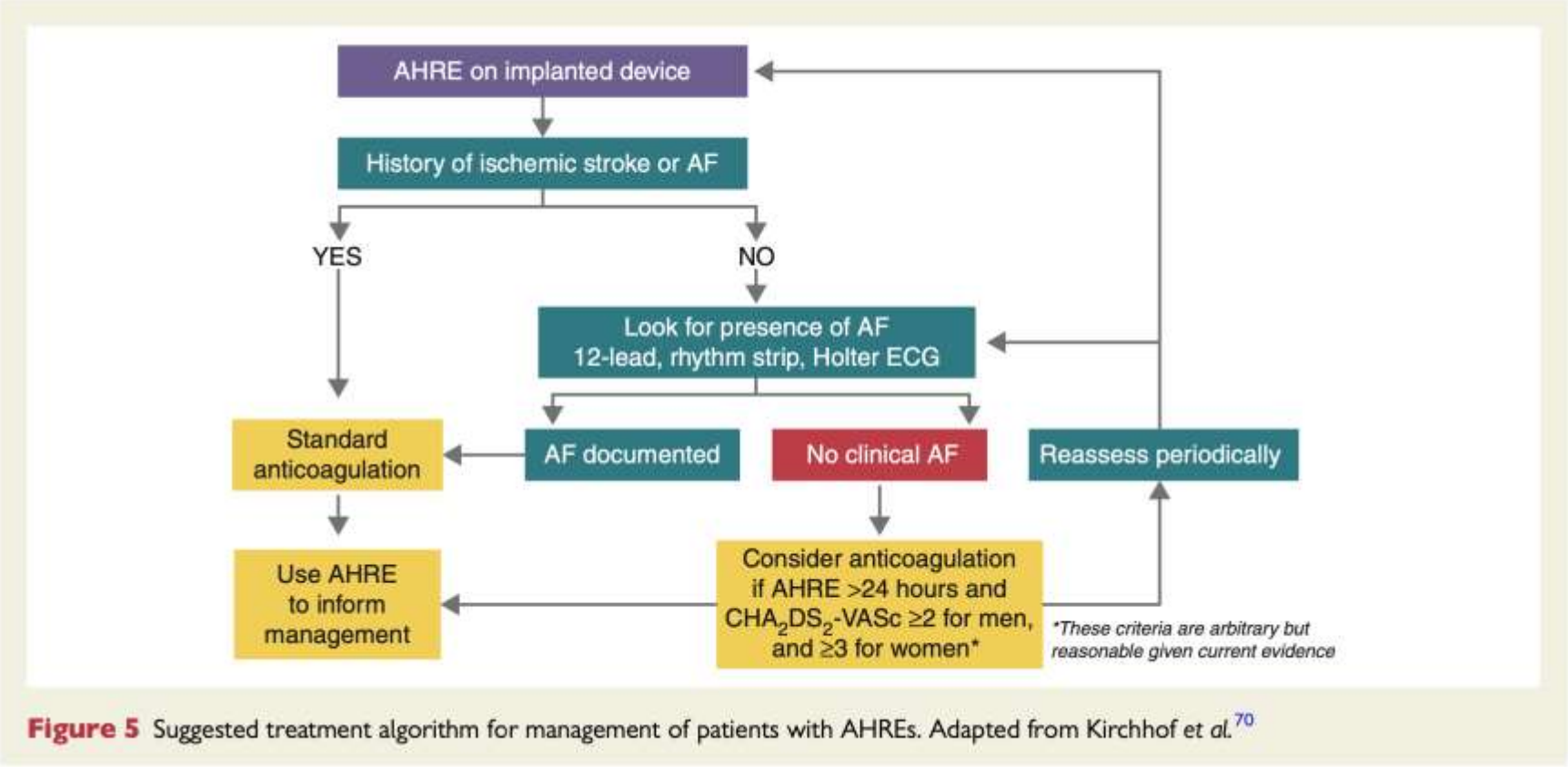
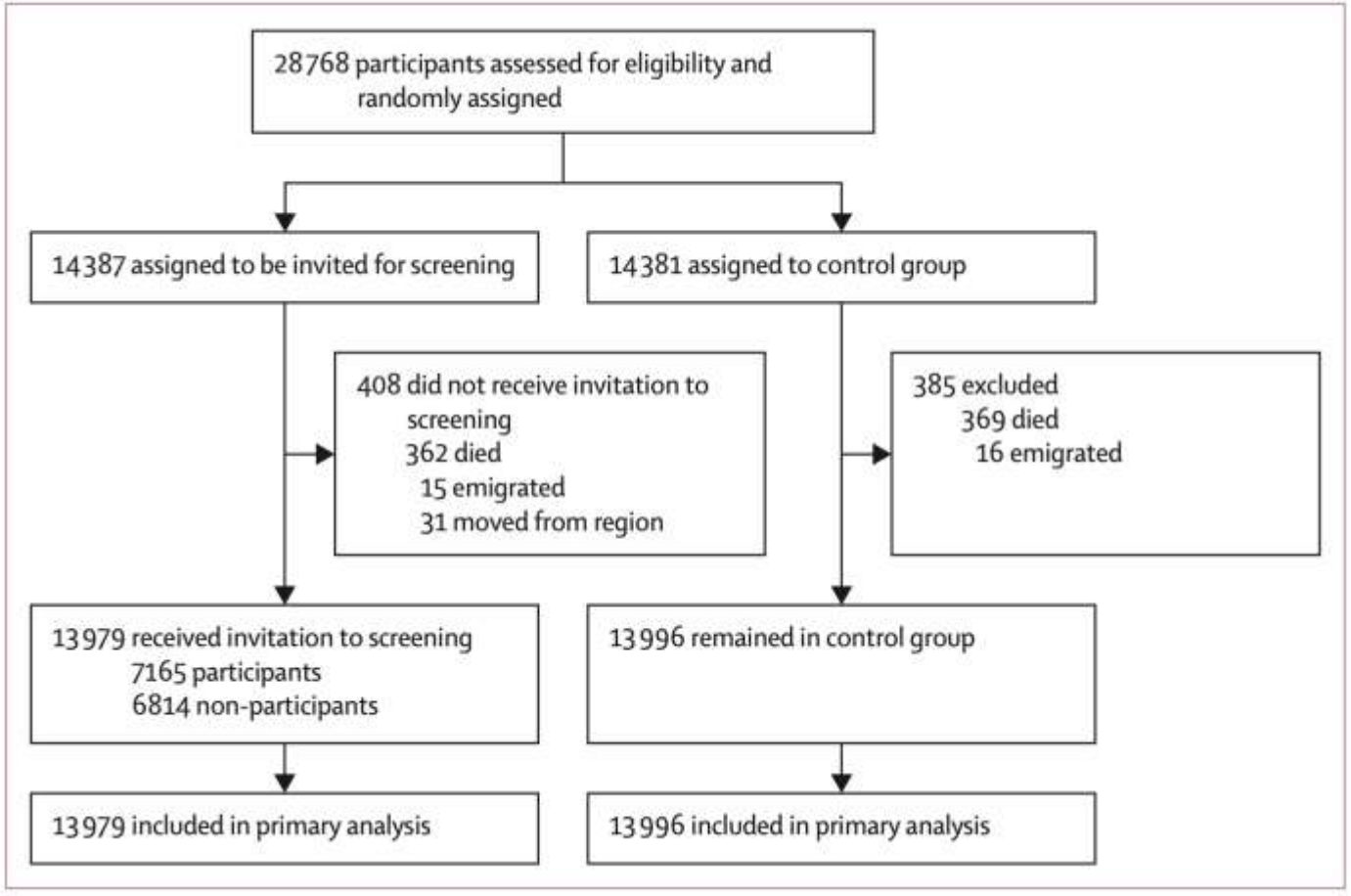


Figure 5 Suggested treatment algorithm for management of patients with AHREs. Adapted from Kirchhof *et al.*[70]

Camm AJ, et al. Europace 2019;19:169-79

Atrial Fibrillation Screening - STROKE-STOP



Svennberg E, et al. Lancet 2021;398:1498-506

Atrial Fibrillation Screening - STROKE-STOP

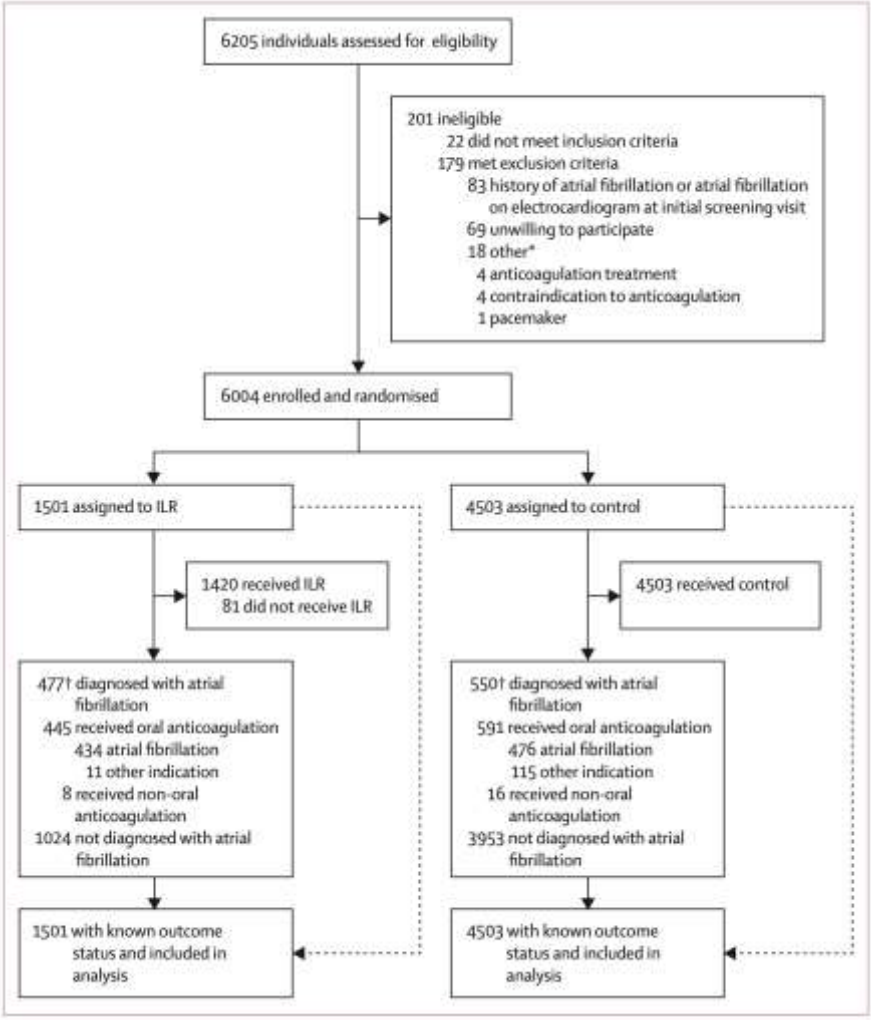
	Invited to screening			Control group			Hazard ratio (95% CI)	p value
	Events*	Years at risk	Events per 100 years (95% CI)	Events*	Years at risk	Events per 100 years (95% CI)		
Composite primary endpoint†	4456	81757	5·45 (5·29–5·61)	4616	81262	5·68 (5·52–5·85)	0·96 (0·92–1·00)	0·045
Ischaemic stroke	766	85068	0·90 (0·84–0·97)	830	84574	0·98 (0·92–1·05)	0·92 (0·83–1·01)	0·084
Haemorrhagic stroke	137	86727	0·16 (0·13–0·19)	155	86309	0·18 (0·15–0·21)	0·88 (0·70–1·11)	0·27
Systemic embolism	60	86808	0·07 (0·05–0·09)	54	86531	0·06 (0·05–0·08)	1·10 (0·76–1·59)	0·60
Hospitalisation for major bleeding	1431	83490	1·71 (1·63–1·81)	1448	83084	1·74 (1·66–1·83)	0·98 (0·91–1·06)	0·65
Death from any cause	3177	86930	3·65 (3·53–3·78)	3287	86614	3·79 (3·67–3·93)	0·96 (0·92–1·01)	0·12
Ischaemic stroke or systemic thromboembolism as randomly assigned	812	84952	0·96 (0·89–1·02)	874	84514	1·03 (0·97–1·11)	0·92 (0·84–1·02)	0·10
Ischaemic stroke or systemic thromboembolism as treated	372	47203	0·79 (0·71–0·87)	874	84514	1·03 (0·97–1·11)	0·76 (0·67–0·85)	<0·0001
New clinical diagnosis of dementia	1164	84258	1·38 (1·30–1·46)	1217	83805	1·45 (1·37–1·54)	0·95 (0·88–1·03)	0·20
Cardiovascular death	1211	86930	1·39 (1·32–1·47)	1197	86614	1·38 (1·31–1·46)	1·01 (0·93–1·09)	0·87
Cardiovascular hospitalisation	3633	76265	4·76 (4·61–4·92)	3659	75919	4·82 (4·67–4·98)	0·99 (0·94–1·04)	0·63
Primary endpoint with the addition of cardiovascular hospitalisation	6101	74283	8·21 (8·01–8·42)	6191	73834	8·38 (8·18–8·60)	0·98 (0·95–0·01)	0·26
Ischaemic or haemorrhagic stroke or dementia	1981	79982	2·48 (2·37–2·59)	2077	79724	2·61 (2·50–2·72)	0·95 (0·89–1·01)	0·098
Pulmonary embolism or venous thromboembolism	577	84873	0·68 (0·63–0·74)	564	84809	0·67 (0·61–0·72)	1·02 (0·91–1·15)	0·71

*Only the first event of each category was counted; therefore, one individual could have had several events of the same kind. †Primary endpoint was a composite of: ischaemic or haemorrhagic stroke, systemic embolism, hospitalisation for bleeding, or death from any cause.

Table 2: **Outcomes**

Svennberg E, et al. Lancet 2021;398:1498-506

Atrial Fibrillation Screening - LOOP



Svendsen JH, et al. Lancet 2021;398:1507-16

Atrial Fibrillation Screening - LOOP

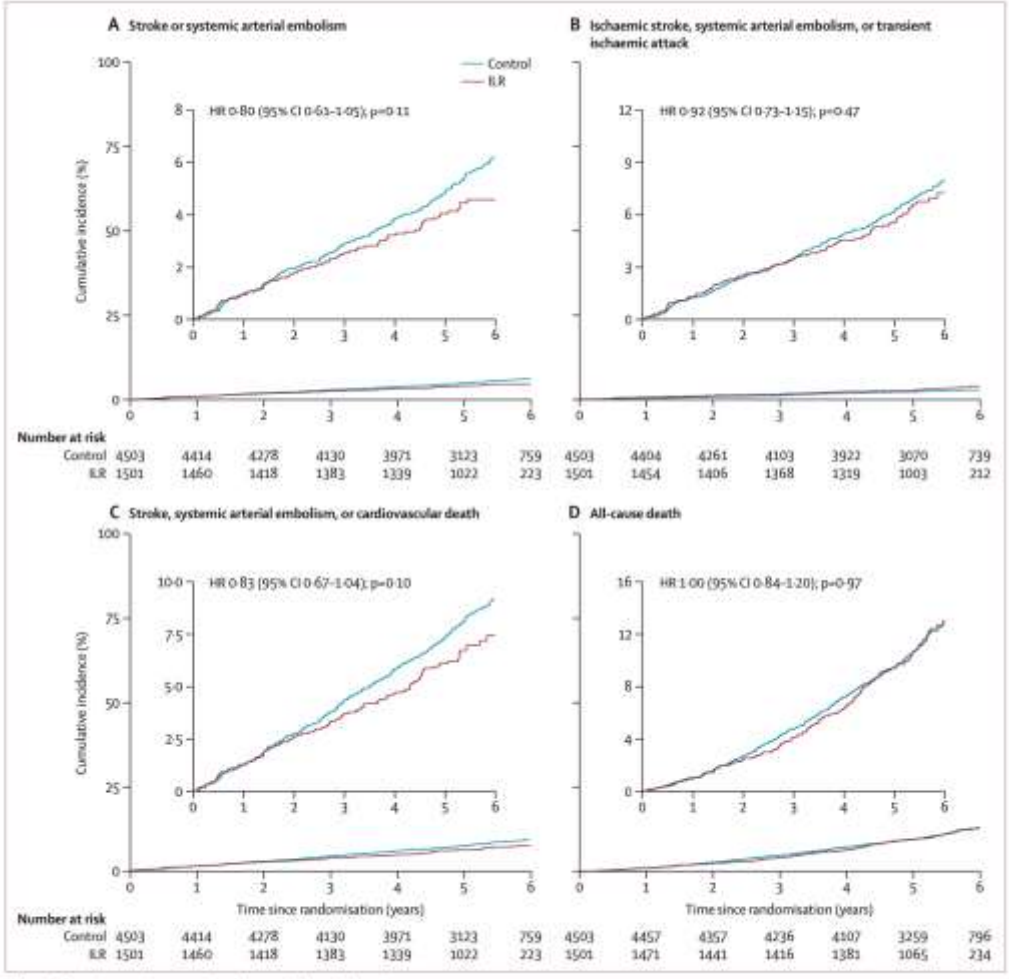


Figure 2: Time-to-event curves for primary and secondary outcomes
Panel A shows the primary outcome, while B, C, and D show secondary outcomes. ILR=implantable loop recorder. HR=hazard ratio.

Svendsen JH, et al. Lancet 2021;398:1507-16

Atrial Fibrillation Screening - LOOP

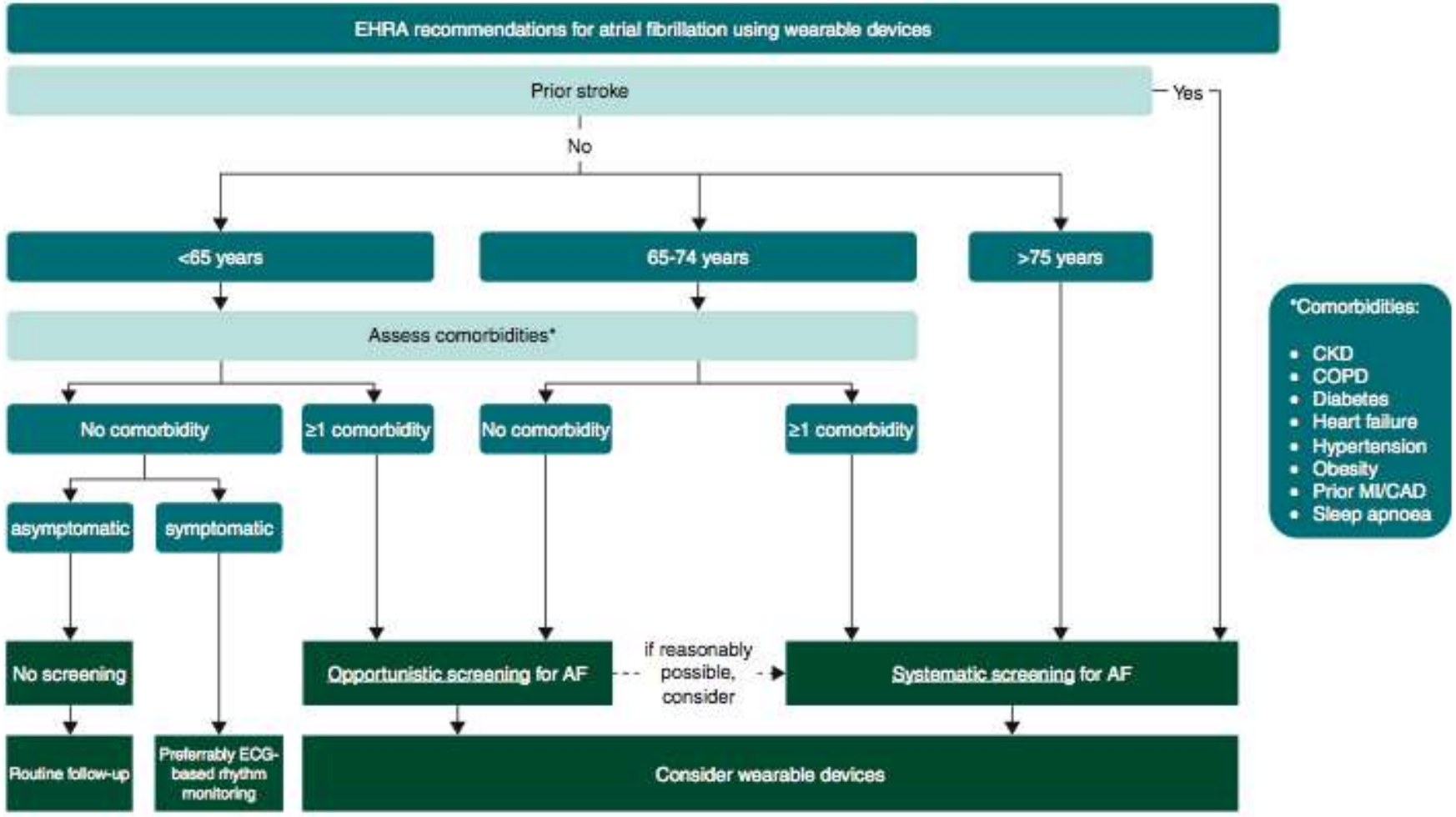
	Number of events		Cumulative incidence rate at 6 years (95% CI)		Events per 100 person-years (95% CI)		Hazard ratio (95% CI)	p value
	ILR group (n=1501)	Control group (n=4503)	ILR group	Control group	ILR group	Control group		
Stroke or systemic arterial embolism	67 (4·5%)	251 (5·6%)	4·61 (3·50–5·73)	6·22 (5·41–7·03)	0·88 (0·68–1·12)	1·09 (0·96–1·24)	0·80 (0·61–1·05)	0·11
Ischaemic stroke, systemic arterial embolism, or transient ischaemic attack	96 (6·4%)	316 (7·0%)	7·20 (5·71–8·70)	7·94 (7·03–8·86)	1·27 (1·03–1·55)	1·39 (1·24–1·55)	0·92 (0·73–1·15)	0·47
Stroke, systemic arterial embolism, or cardiovascular death	104 (6·9%)	376 (8·3%)	7·44 (5·95–8·93)	9·16 (8·20–10·12)	1·36 (1·11–1·65)	1·64 (1·48–1·81)	0·83 (0·67–1·04)	0·10
Cardiovascular death	43 (2·9%)	157 (3·5%)	3·23 (2·16–4·30)	3·77 (3·14–4·40)	0·55 (0·40–0·74)	0·67 (0·57–0·78)	0·83 (0·59–1·16)	0·27
All-cause death	168 (11·2%)	507 (11·3%)	13·02 (10·96–15·08)	12·80 (11·65–13·96)	2·16 (1·84–2·51)	2·16 (1·97–2·35)	1·00 (0·84–1·19)	1·00
Major bleeding	65 (4·3%)	156 (3·5%)	4·88 (3·67–6·10)	3·69 (3·10–4·29)	0·85 (0·66–1·08)	0·67 (0·57–0·79)	1·26 (0·95–1·69)	0·11
Haemorrhagic stroke	11 (0·8%)	34 (0·8%)	0·80 (0·32–1·29)	0·81 (0·53–1·10)	0·14 (0·07–0·25)	0·14 (0·10–0·20	0·97 (0·49–1·92)	0·94
Traumatic intracranial haemorrhage	10 (0·9%)	36 (0·8%)	0·81 (0·29–1·33)	0·90 (0·59–1·21)	0·13 (0·06–0·24)	0·15 (0·11–0·21	0·84 (0·41–1·68)	0·61
Atrial fibrillation	477 (31·8%)	550 (12·2%)	32·24 (29·84–34·65)	13·62 (12·47–14·78)	8·04 (7·34–8·80)	2·48 (2·27–2·69)	3·17 (2·81–3·59)	<0·0001
Oral anticoagulation	445 (29·7%)	591 (13·1%)	30·25 (27·82–32·67)	14·58 (13·37–15·79)	7·39 (6·72–8·11)	2·68 (2·46–2·90)	2·72 (2·41–3·08)	<0·0001

Data are n (%) or as specified. ILR=implantable loop recorder.

Table 2: **Outcomes and adverse events**

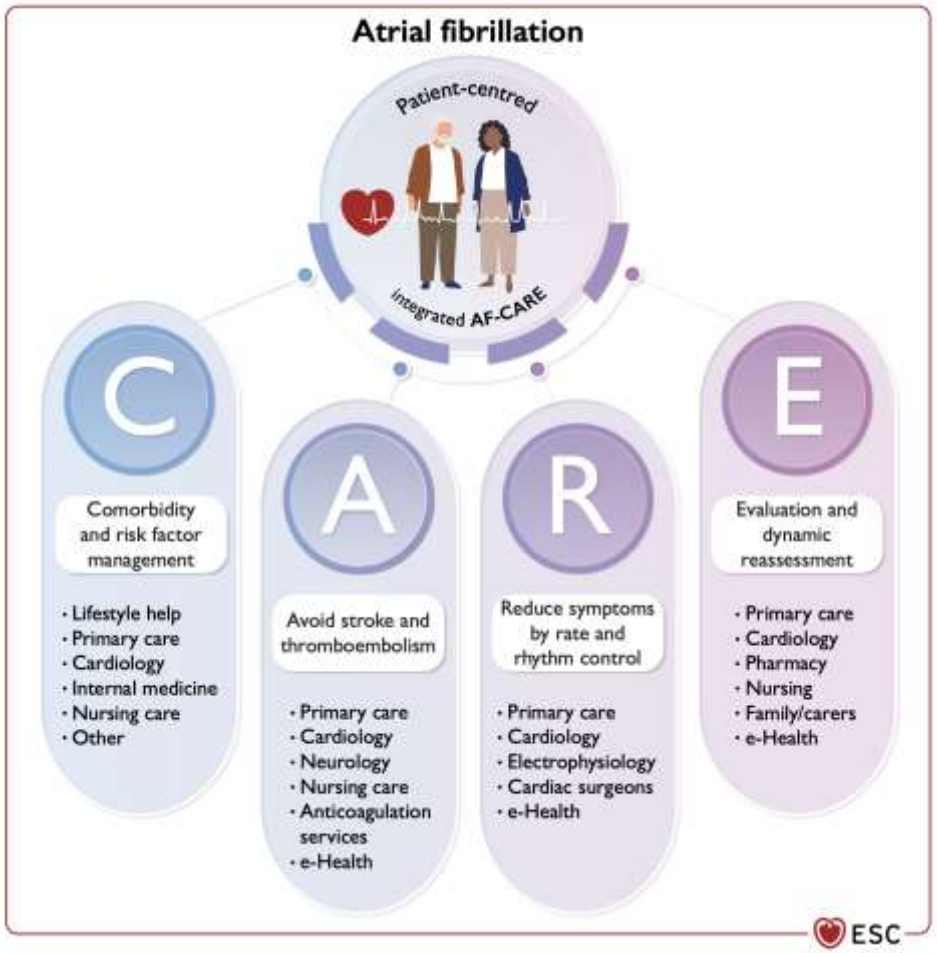
Svendsen JH, et al. Lancet 2021;398:1507-16

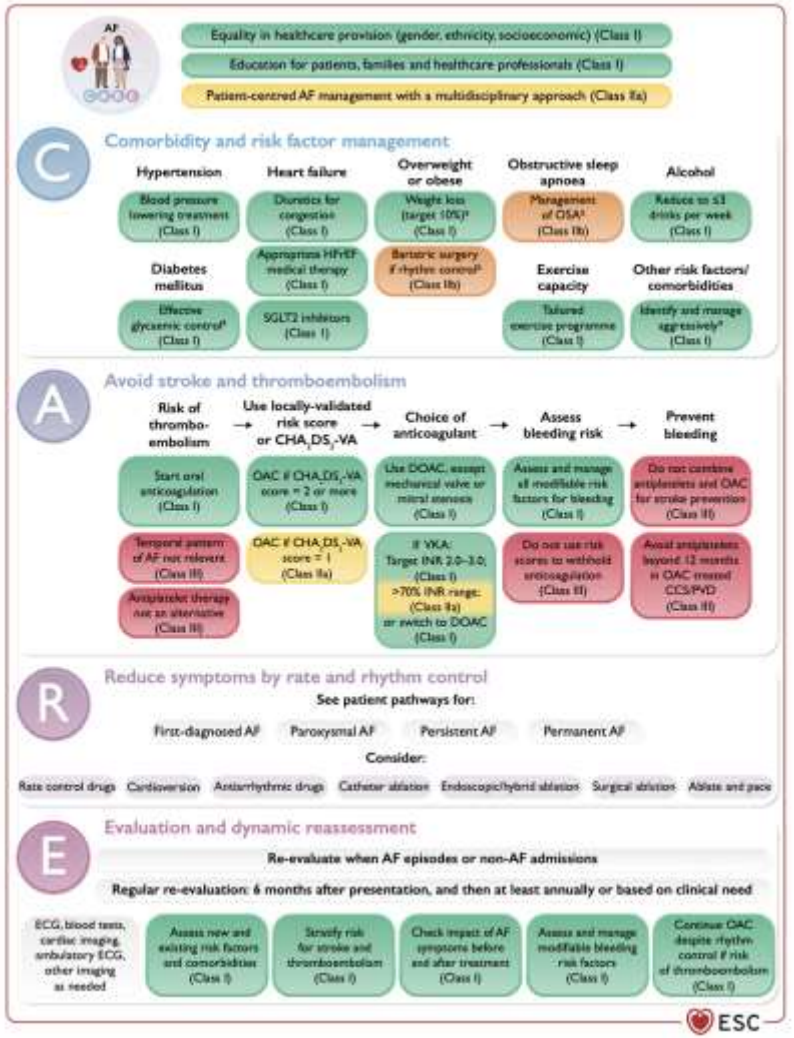
Atrial Fibrillation – Screening (EHRA Practical Guide)



Svennberg E, et al Europace 2022

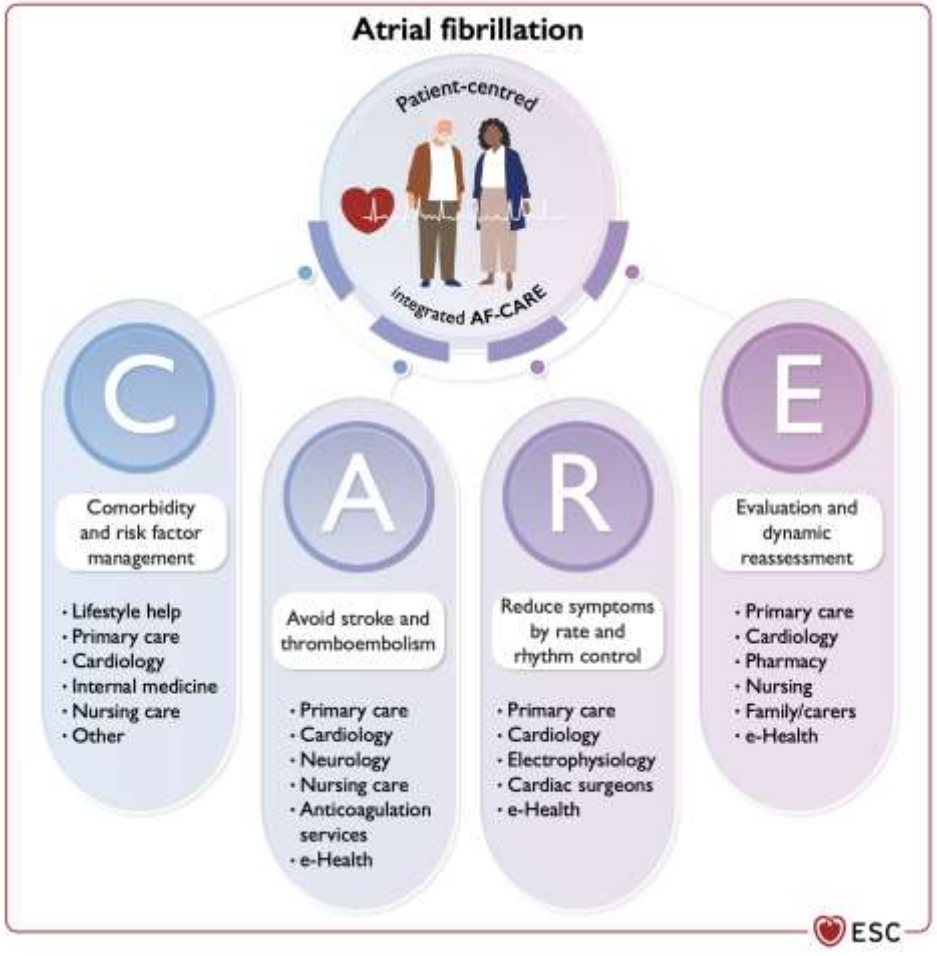
Atrial Fibrillation – Latest Guidelines

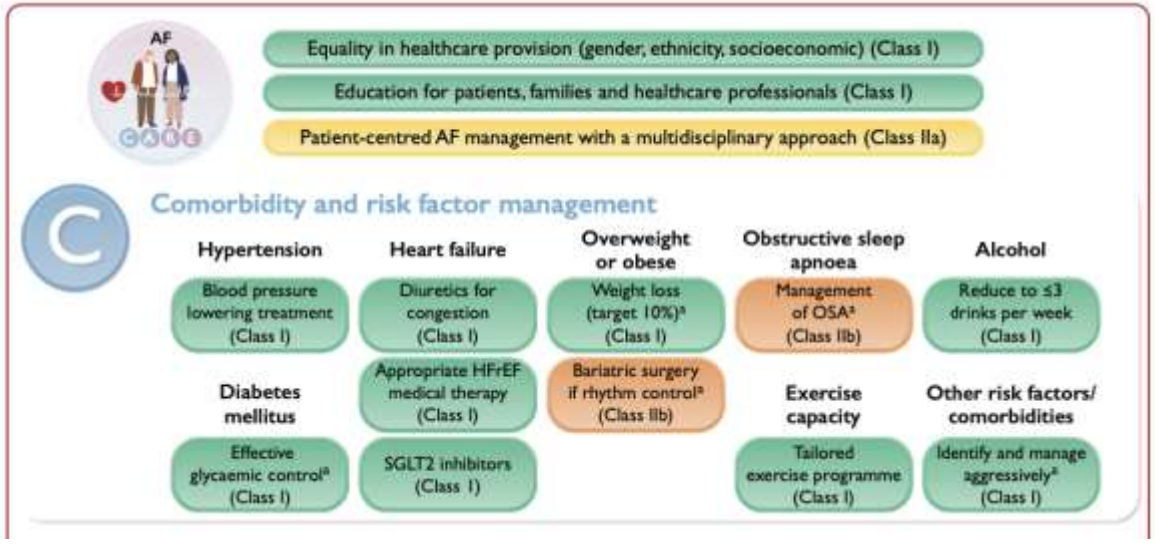




Gelder IC, et al. Eur Heart J 2024

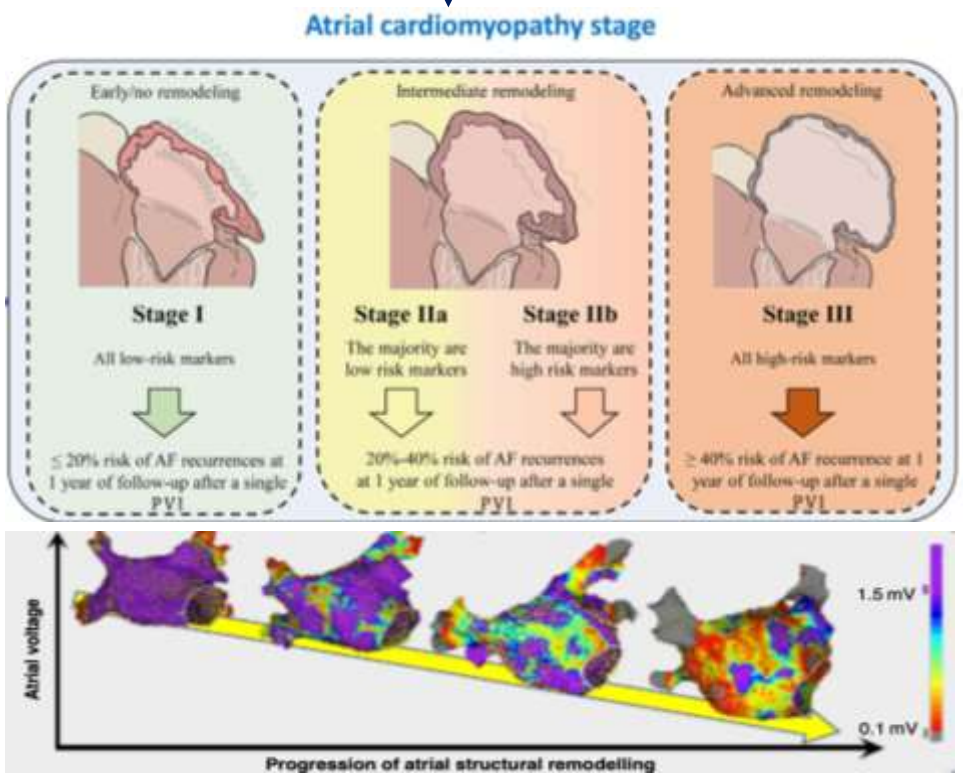
Atrial Fibrillation – Latest Guidelines

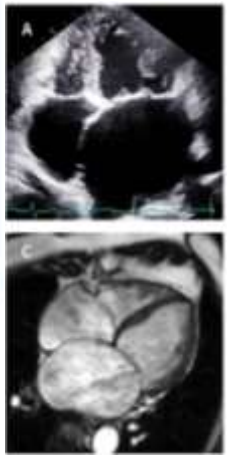


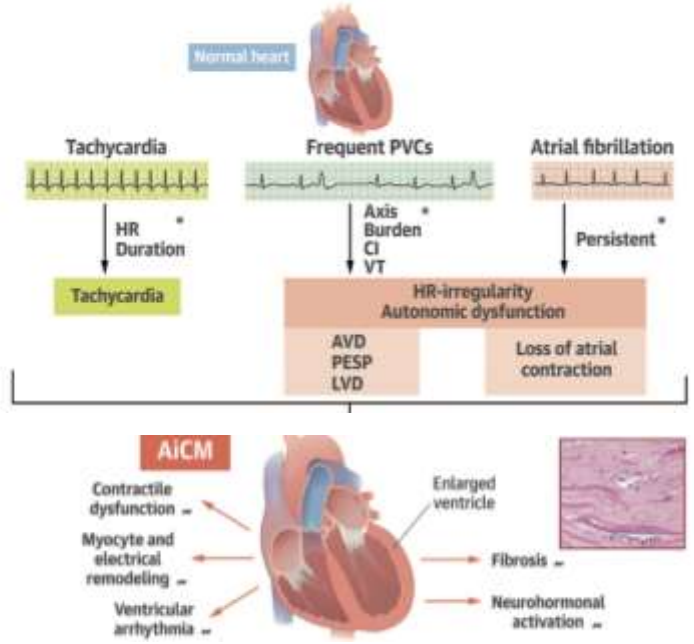


Gelder IC, et al. Eur Heart J 2024

AF Management in Atrial Cardiomyopathy and in HFrEF

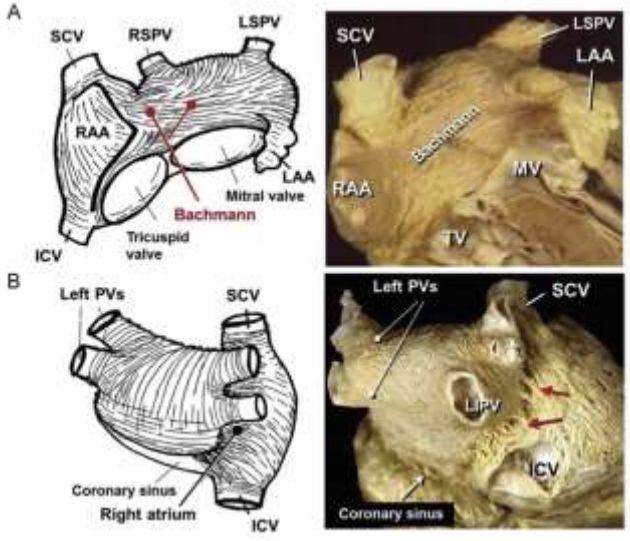


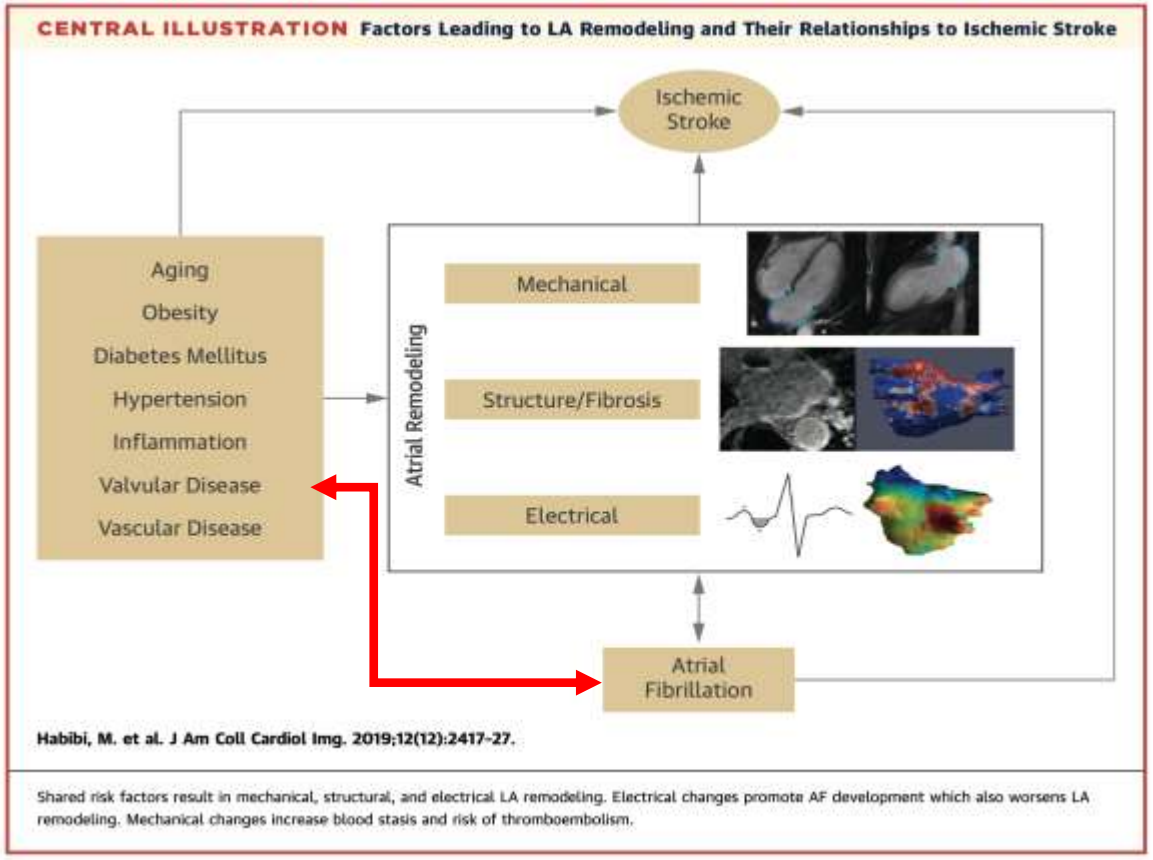


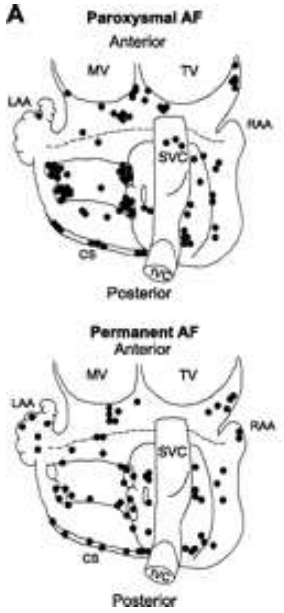


Shoureshi P, et al. J Am Coll Cardiol 2024;83:2214-32
Goette A, et al Europace 2024

Atrial Cardiomyopathy – Pathophysiology





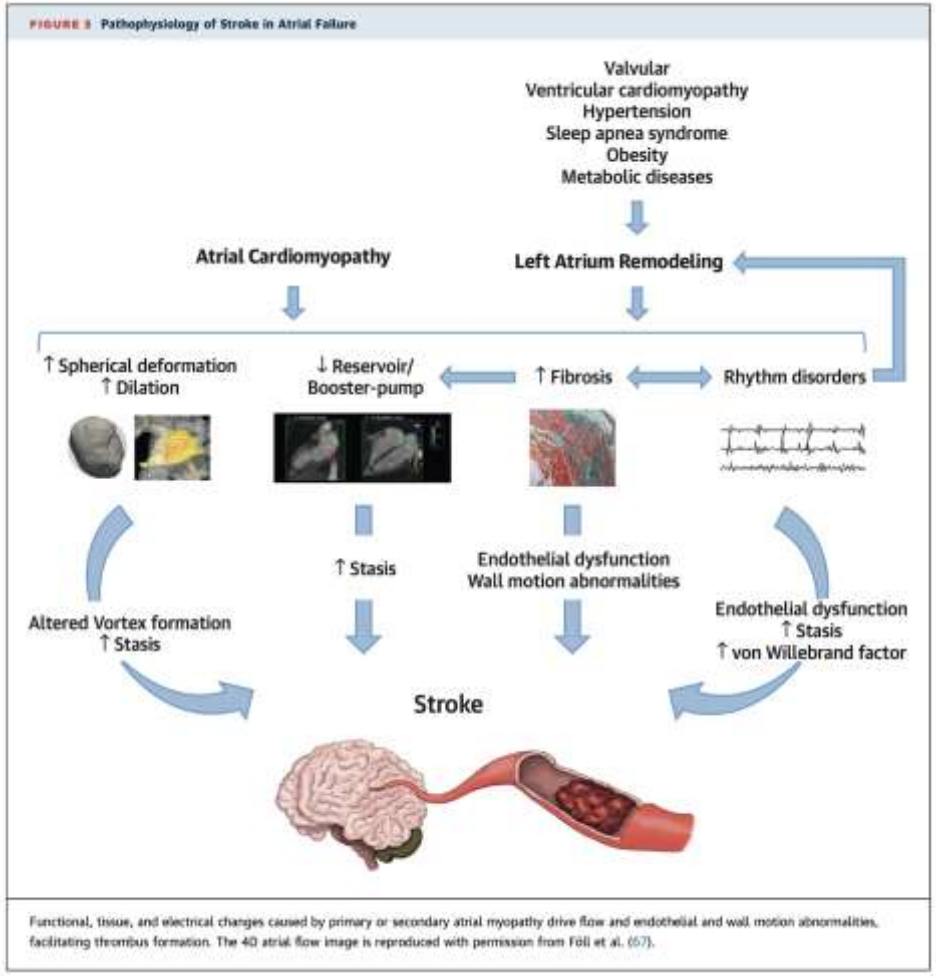


To date the pathogenesis of ACM has not been completely clarified

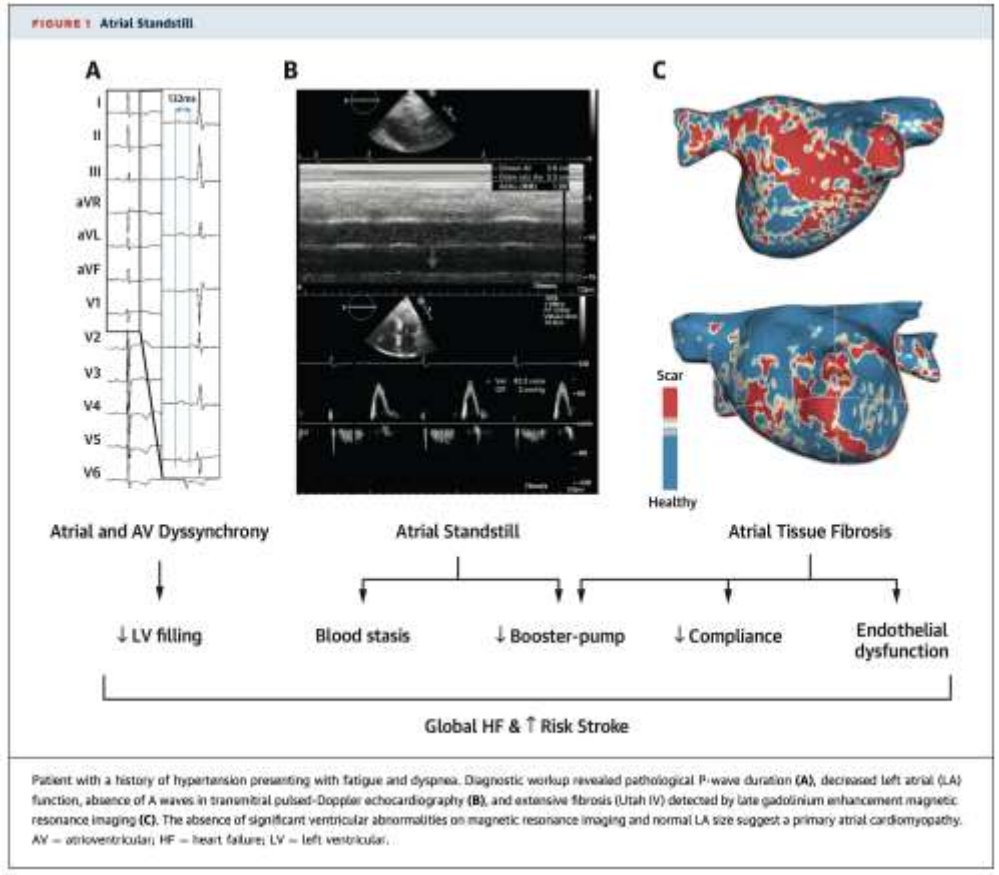
Goette A, et al. J Arrhythmia 2016;32:247-78

Habibi M, et al. J Am Coll Cardiol 2019;12:2417-27

Atrial Cardiomyopathy – Atrial Failure – Stroke



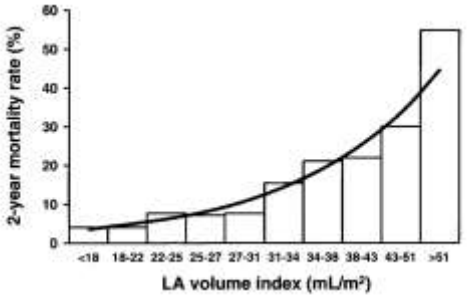
Functional, tissue, and electrical changes caused by primary or secondary atrial myopathy drive flow and endothelial and wall motion abnormalities, facilitating thrombus formation. The 4D atrial flow image is reproduced with permission from Föll et al. (67).



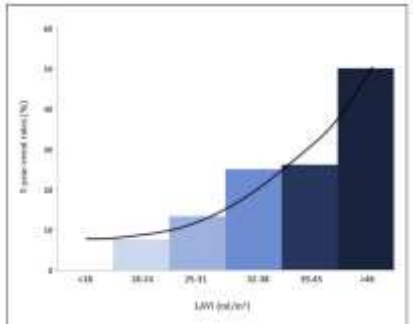
Patient with a history of hypertension presenting with fatigue and dyspnea. Diagnostic workup revealed pathological P-wave duration **(A)**, decreased left atrial (LA) function, absence of A waves in transmitral pulsed-Doppler echocardiography **(B)**, and extensive fibrosis (Utah IV) detected by late gadolinium enhancement magnetic resonance imaging **(C)**. The absence of significant ventricular abnormalities on magnetic resonance imaging and normal LA size suggest a primary atrial cardiomyopathy. AV = atrioventricular; HF = heart failure; LV = left ventricular.

Bisbal F, et al. J Am Coll Cardiol 2020;75:222-32

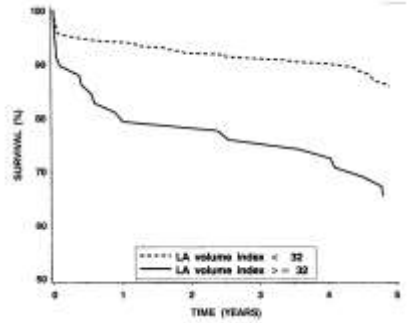
Arrhythmia-induced Cardiomyopathy – Impact on different patient population



ACS



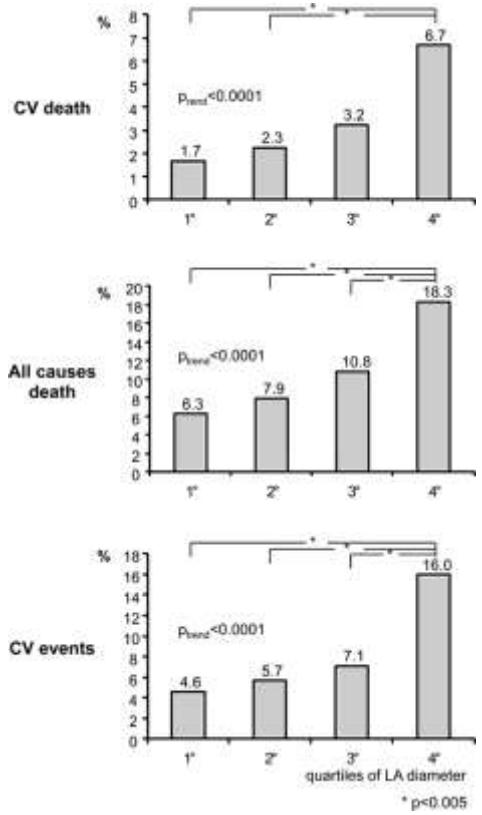
Diabetics



CCS

Marker	Model 1*
Individual markers	
PTFV$_1$ alone‡ (n=4954)	1.08 (1.04–1.11)
Left atrial dimension alone§ (n=4919)	1.15 (1.03–1.29)
NT-proBNP alone‖ (n=3992)	1.17 (1.11–1.24)
AF alone¶ (n=5120)	2.18 (1.85–2.57)

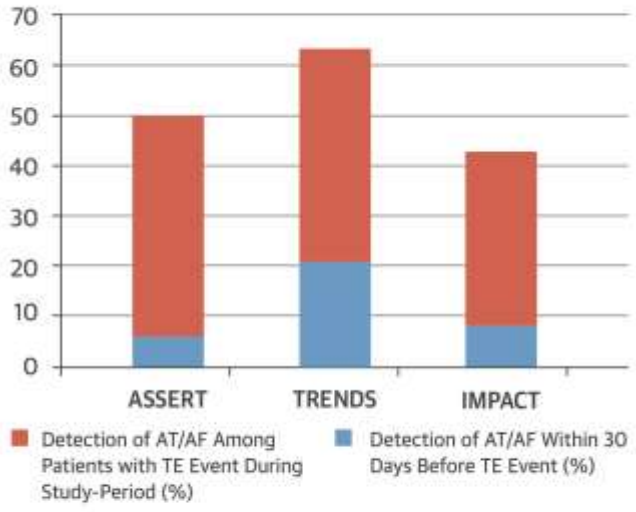
Stroke



Beinart R, et al. J Am Coll Cardiol 2004;44:327-34
Poulsen MK, et al. J Am Coll Cardiol 2013;62:2416-21
Moller JE, et al. Circulation 2003;107:2207-12
Kamel H, et al. Stroke 2018;49:980-6
Bombelli L, et al. Hypertension 2014

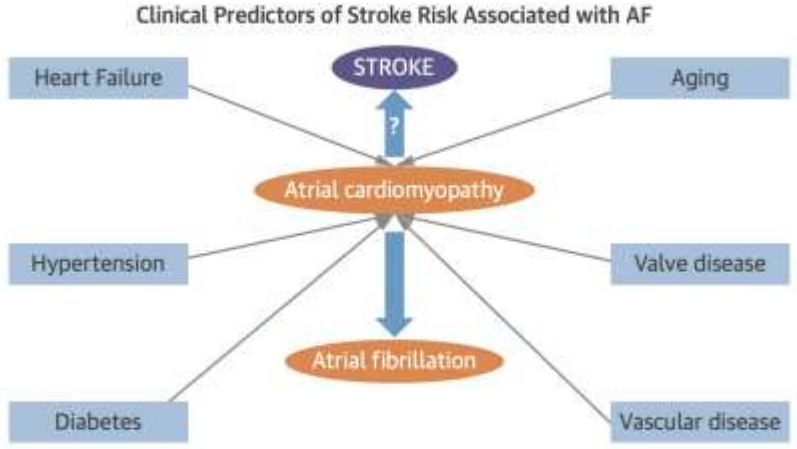
Fibrotic atrial Cardiomyopathy, AF and Thrombembolism

FIGURE 3 Temporal Dissociation Among Patients With an Embolic Event in the ASSERT, TRENDS, and IMPACT Studies



Percentage of patients who had AT/AF in the 30 days before the event **(blue)** compared with the percentage of AT/AF detected at any time during the study period **(salmon)**. AF = atrial fibrillation; AT = atrial tachycardia; TE = thromboembolic.

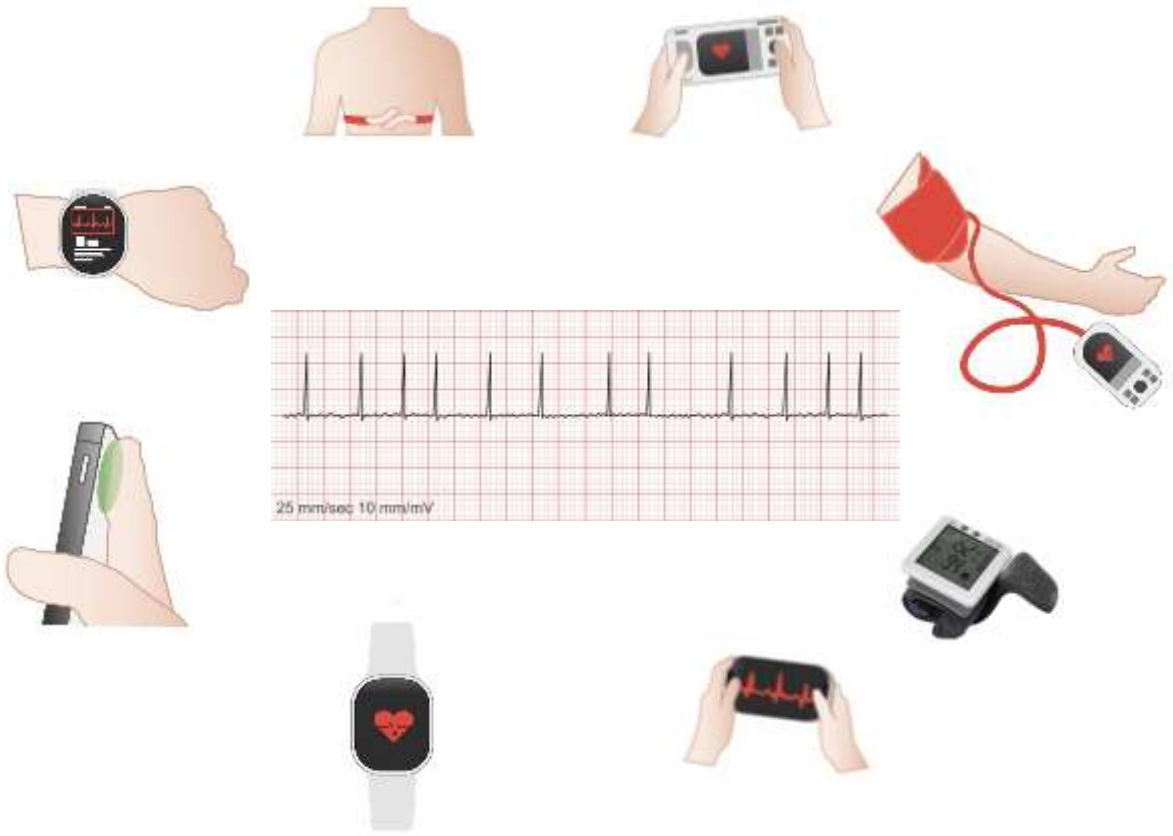
FIGURE 1 Clinical Predictors of Stroke Risk Incorporated in the $CHADS_2$ and CHA_2DS_2-VASc Schemes All-Cause Atrial Cardiomyopathy

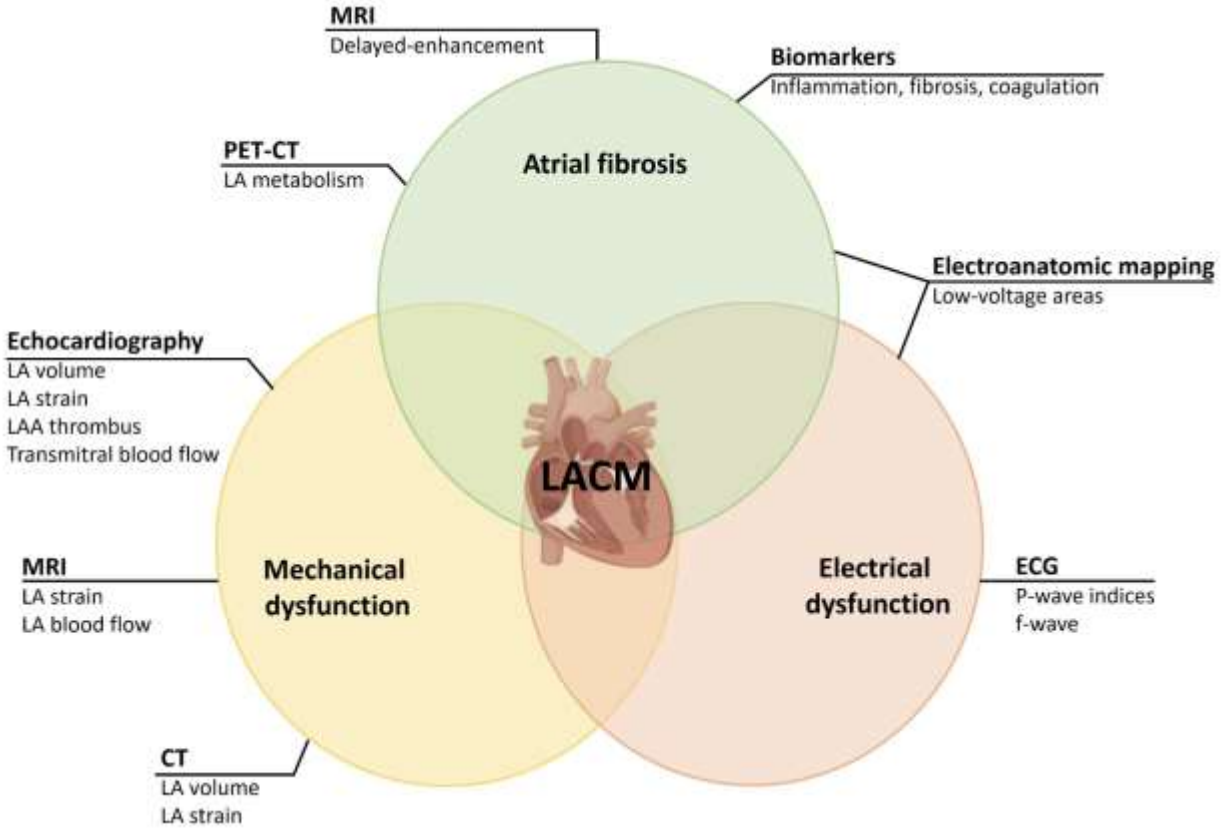


This observation supports the idea that atrial cardiomyopathy may be a direct contributor to stroke risk. CHA_2DS_2-VASc = congestive heart failure, hypertension, age ≥75 years, diabetes mellitus, prior stroke or transient ischemic attack or thromboembolism, vascular disease, age 65 to 74 years, sex category; $CHADS_2$ = congestive heart failure, hypertension, age ≥75 years, diabetes mellitus, prior stroke or transient ischemic attack or thromboembolism.

Hirsh BJ, et al. J Am Coll Cardiol 2015;65:2239-51

Arrhythmia-induced Cardiomyopathy – Diagnosis

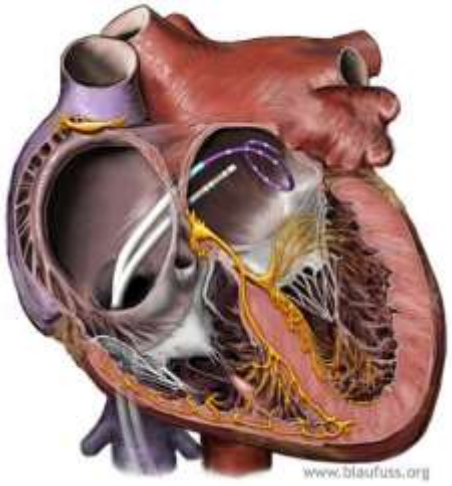


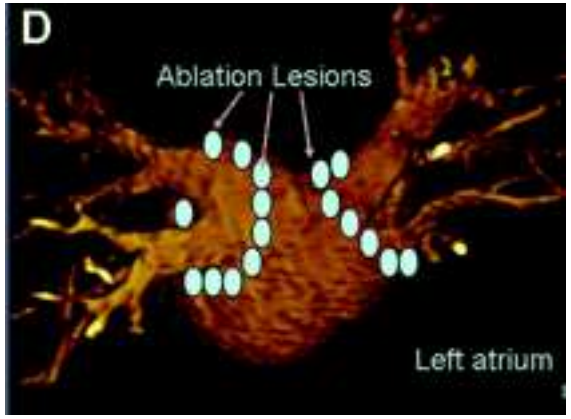


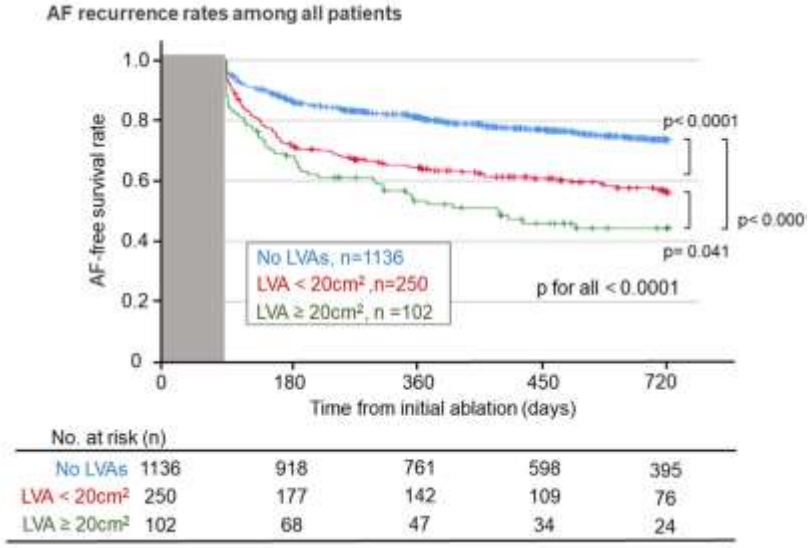
There are still no established criteria for the diagnosis of atrial cardiomyopathy

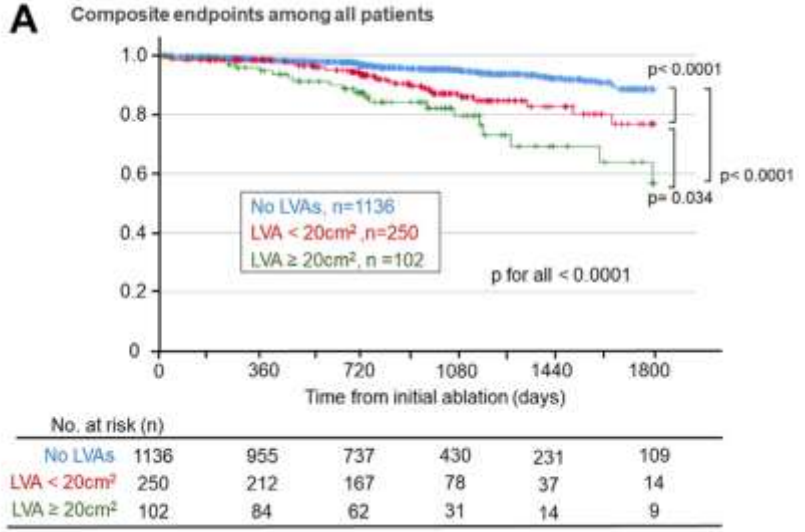
Kreimer F, et al. Front Cardiovasc Med 2022

Clinical Impact of Atrial Cardiomyopathy on AF Recurrence after PVI



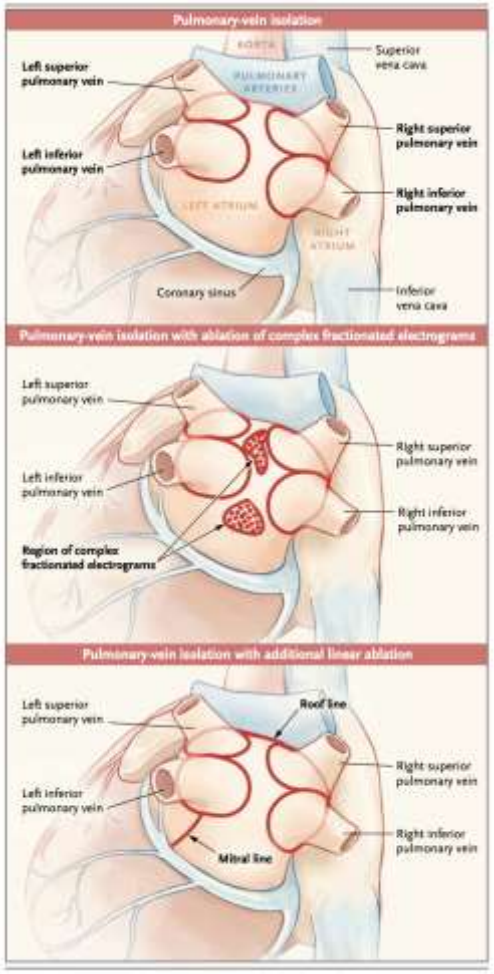






Masuda M, et al. Haert Rhythm 2024;21:378-86

Ablation strategy in pers. AF and outcome – STAR AF II Trial / CAPLA Trial / DECAAF Trial / DECAAF II Trial



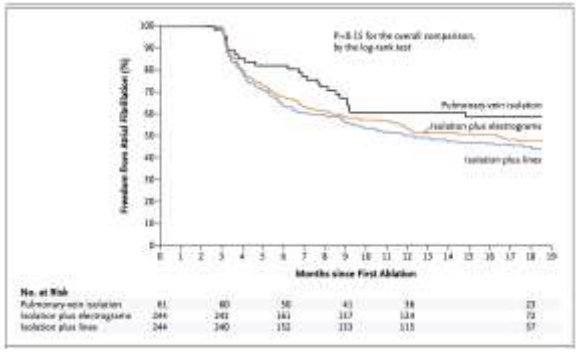
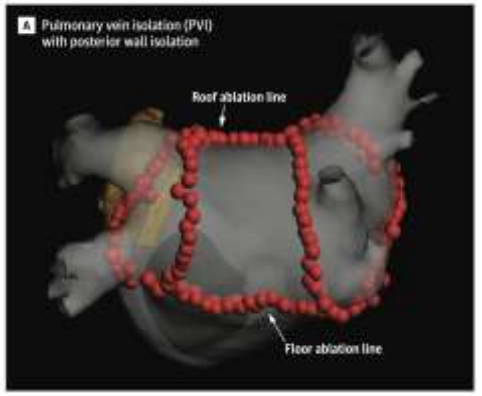


Figure 1. Pulmonary Vein Isolation With and Without Posterior Wall Isolation



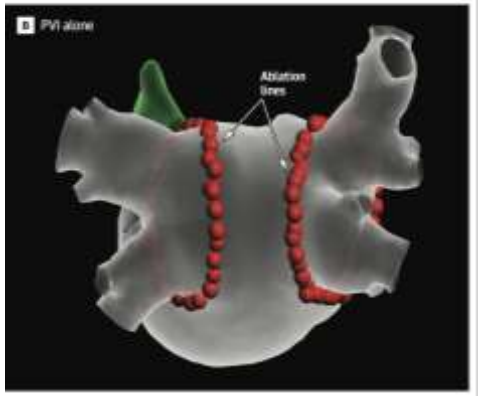
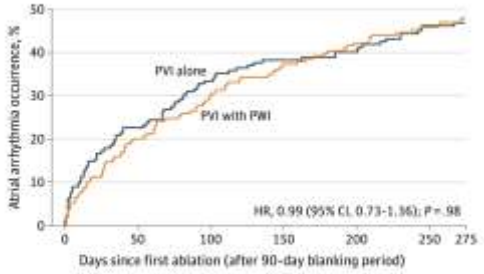


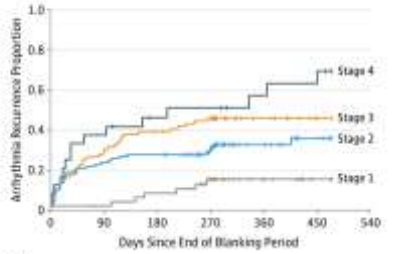
Figure 3. Any Atrial Arrhythmia Recurrence, Without Antiarrhythmic Medication, After a Single Ablation Procedure



Cumulative No. of events

PVI alone	0	46	61	65	72	78	78
PVI with PWI	0	42	58	66	74	81	81

Figure 4. Cumulative Incidence of Arrhythmia Recurrence Without Covariate Adjustment Through Day 475 After the Blanking Period

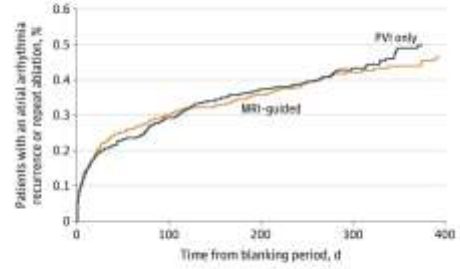


No. at risk

Stage 4	24	15	11	10	7	6
Stage 3	80	56	47	41	19	12
Stage 2	107	78	74	58	26	15
Stage 1	49	47	43	33	13	4

Small vertical ticks on curves indicate where a patient's follow-up has completed without recurrent atrial fibrillation.

Figure 2. Primary Composite of Atrial Arrhythmia Recurrence or Repeat Ablation



No. at risk

MRI-guided	407	277	251	114	64
PVI only	408	284	249	118	69

Verma A, et al. N Engl J Med 2015;372:1812-22
Kister PM, et al. JAMA 2023;329:127-35
Marrouche NF, et al. JAMA 2014;311:498-506
Marrouche NF, et al. JAMA 2022;327:2296-305

Early PVI and Impact on AF Progression (EARLY-AF)

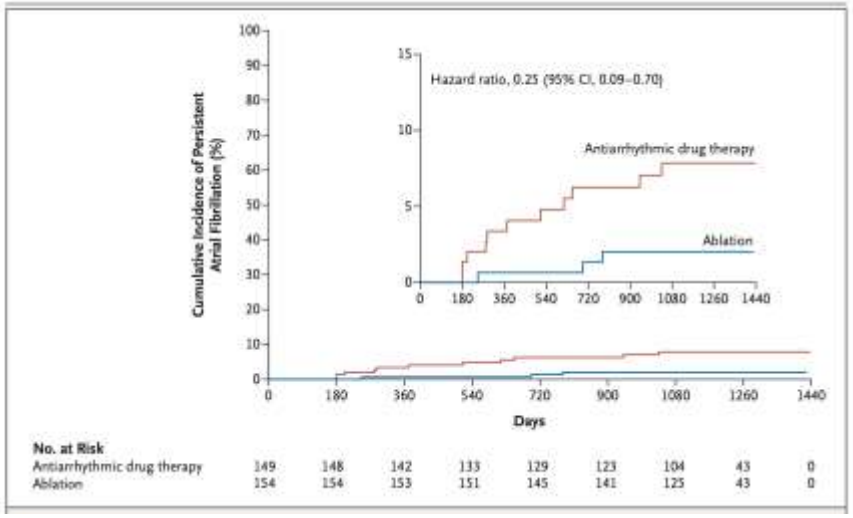


Table 1. Main End Points of Interest.*

End Point	Ablation Group (N=154)	Antiarrhythmic Drug Group (N=149)	Hazard Ratio (95% CI)
	number (percent)		
Progression to persistent atrial fibrillation from 91 days after treatment initiation to final follow-up	3 (1.9)	11 (7.4)	0.25 (0.09–0.70)
Recurrence of any atrial tachyarrhythmia			
From 91 days to 12 mo after treatment initiation†	66 (42.9)	101 (67.8)	0.48 (0.35–0.66)
From 91 days to 36 mo after treatment initiation	87 (56.5)	115 (77.2)	0.51 (0.38–0.67)
Hospitalization			
No. of patients with event (%)	8 (5.2)	25 (16.8)	0.31 (0.14–0.66)
No. of events	9	29	
Median no. of events per patient among those with an event (IQR)	1 (1–1)	1 (1–1)	

Patient with paroxysmal AF

Catheter ablation[a] (Class I)

Patient with persistent AF

Catheter ablation[a] (Class IIb)

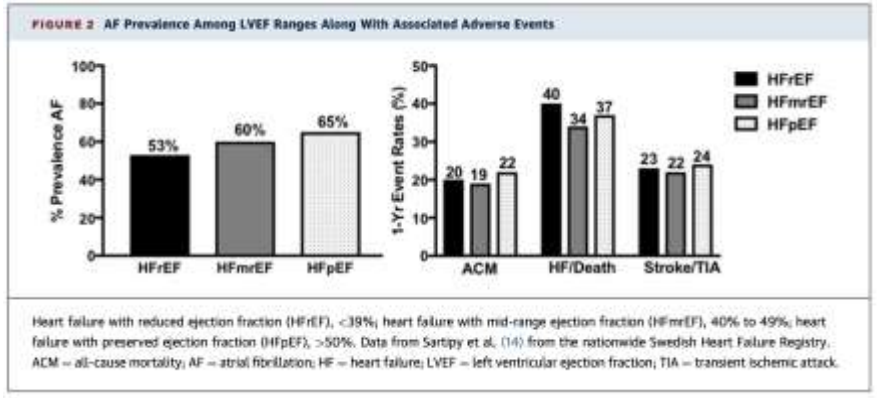
Patient with permanent AF

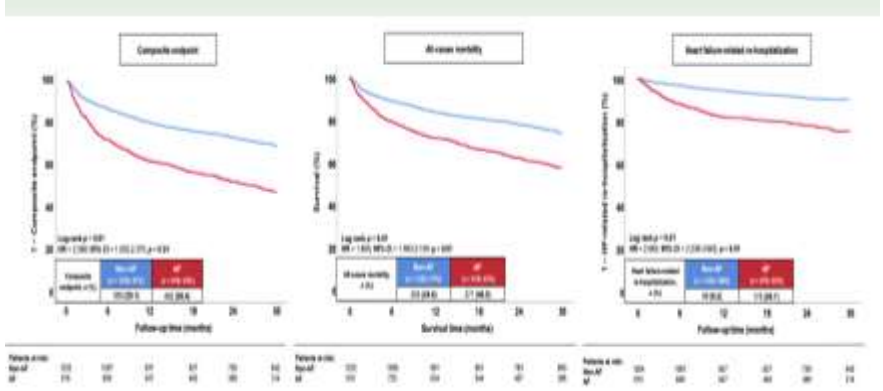
Rate control target = resting heart rate <110 b.p.m. (lenient control), with stricter control with continuing symptoms (Class IIa)

Atrioventricular node ablation and CRT (Class IIa)

Andrade LG, et al. N Engl J Med 2023
Van Gelder, et al. Eur Heart J 2024

AF in Different Form of HF





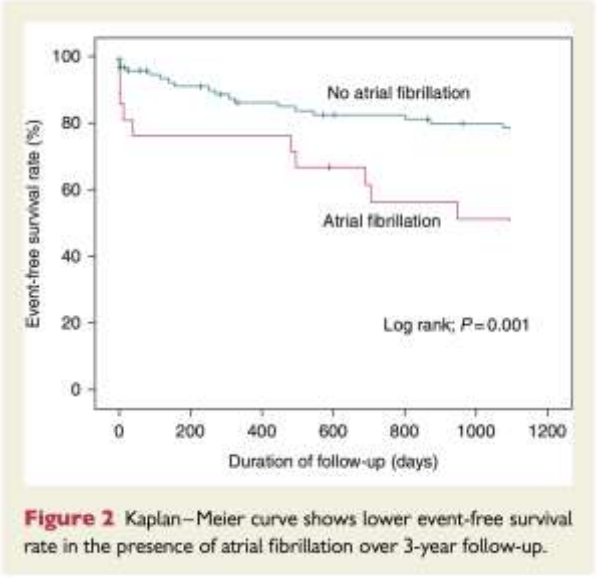
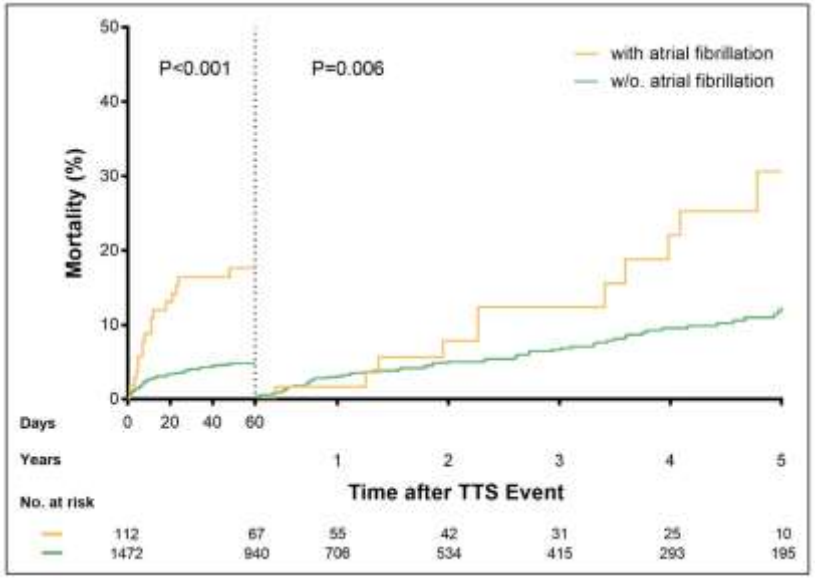
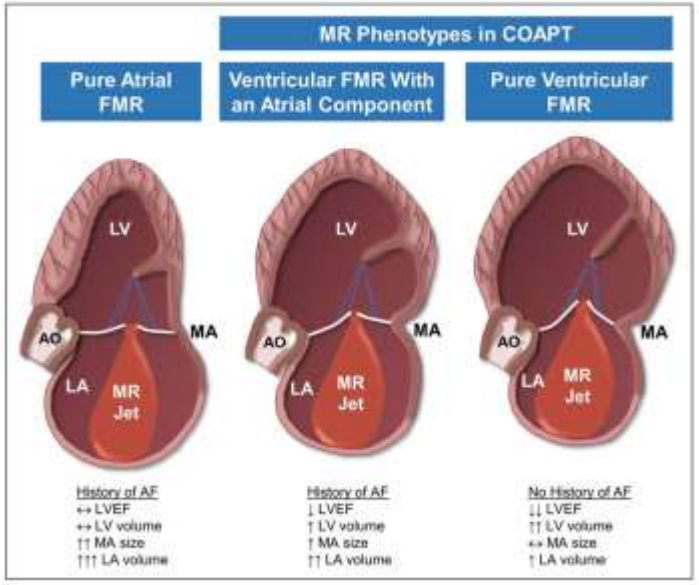


Figure 2 Kaplan–Meier curve shows lower event-free survival rate in the presence of atrial fibrillation over 3-year follow-up.



Schupp T, … Akin I. Eur J Prev Cardiol 2024
El-Battrawy I, … Akin I. Europace 2017;19:1288-92
El-Battrawy I, … Akin I. JAHA 2021;10:e14059
Carlise MA, et al. JACC Heart Fail 2019;7:447-56

Arrhythmia-induced Cardiomyopathy – Atrial and Ventricular FMR and Association with Atrial Fibrillation



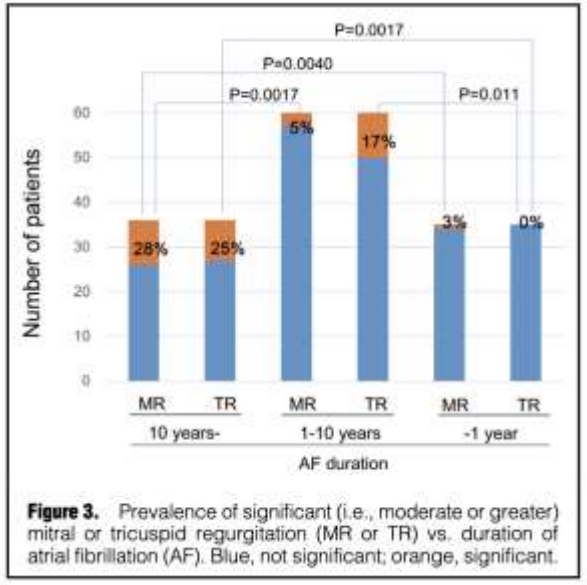


Figure 3. Prevalence of significant (i.e., moderate or greater) mitral or tricuspid regurgitation (MR or TR) vs. duration of atrial fibrillation (AF). Blue, not significant; orange, significant.

Table 1. Baseline Demographic and Clinical Characteristics of the Patients with Heart Failure and Moderate-to-Severe Functional Mitral Regurgitation.*

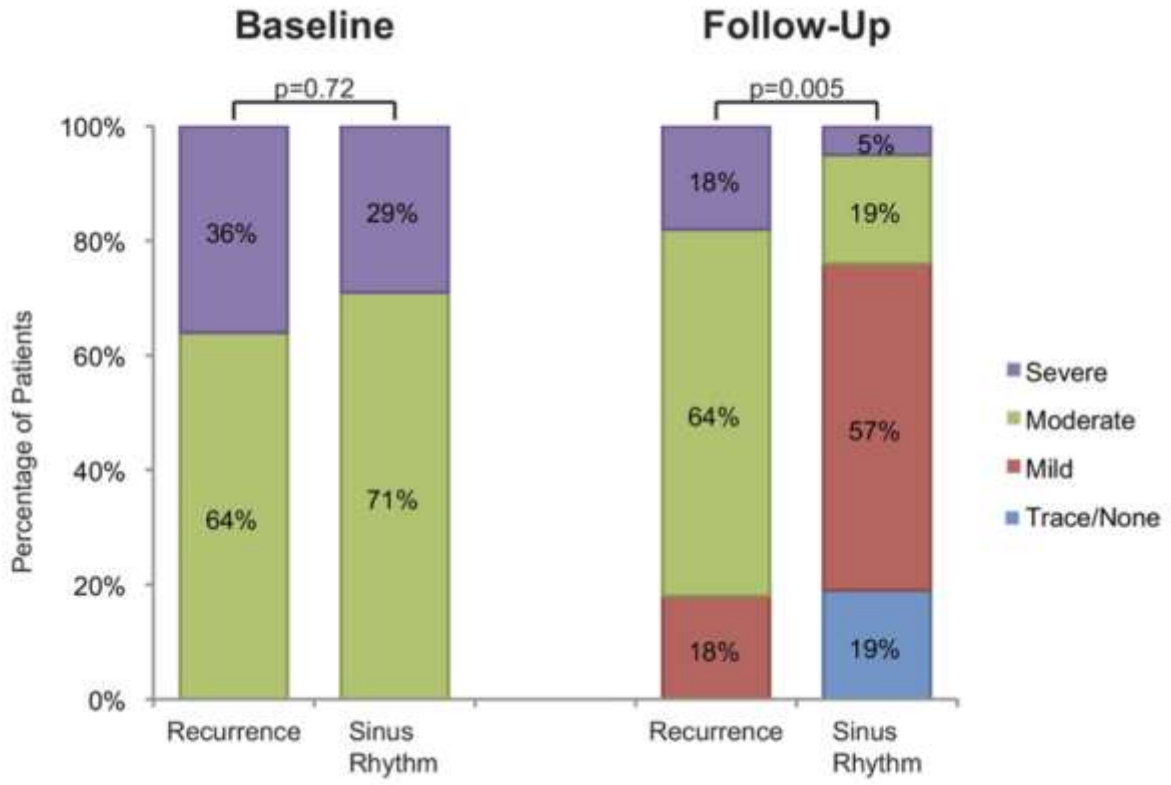
Characteristic	Device Group (N=250)	Control Group (N=255)
Age — yr	70.0±10.4	69.4±10.7
Male sex — no. (%)	195 (78.0)	211 (82.8)
Diabetes — no. (%)	91 (36.4)	85 (33.3)
Hypertension — no. (%)	141 (56.4)	127 (49.8)
Previous myocardial infarction — no. (%)	144 (57.6)	135 (52.9)
Previous PCI — no. (%)	118 (47.2)	125 (49.0)
Previous CABG — no. (%)	69 (27.6)	64 (25.1)
Previous stroke or TIA — no. (%)	29 (11.6)	30 (11.8)
Peripheral vascular disease — no. (%)	38 (15.2)	27 (10.6)
History of atrial fibrillation or flutter — no. (%)	118 (47.2)	125 (49.0)

Gertz ZM, et al. Circ Cardiovasc Interv 2021
Shoureshi P, et al. J Am Coll Cardiol 2024;83:2214-32
Abe Y, et al. Circ J 2018;82:1451-58
Anker S, et al N Engl J Med 2024

Atrial and Ventricular FMR - Association with AF

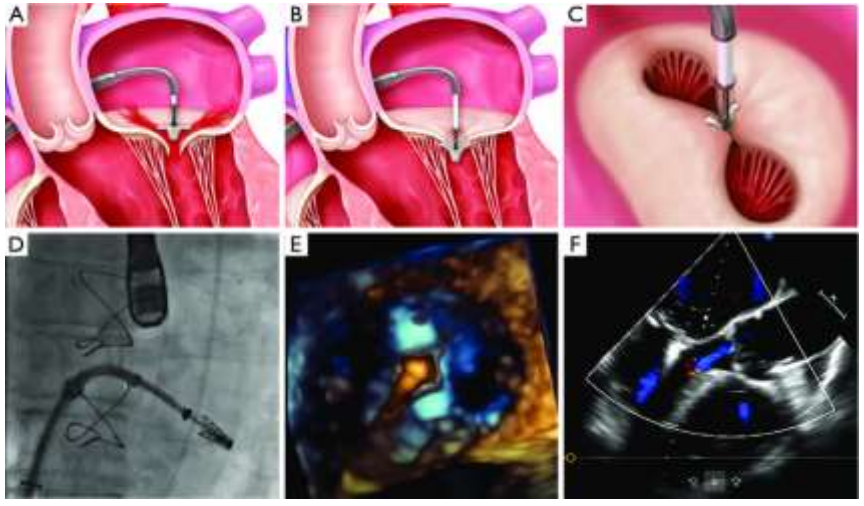
Table 2 Echocardiographic Characteristics of the MR and Reference Cohorts

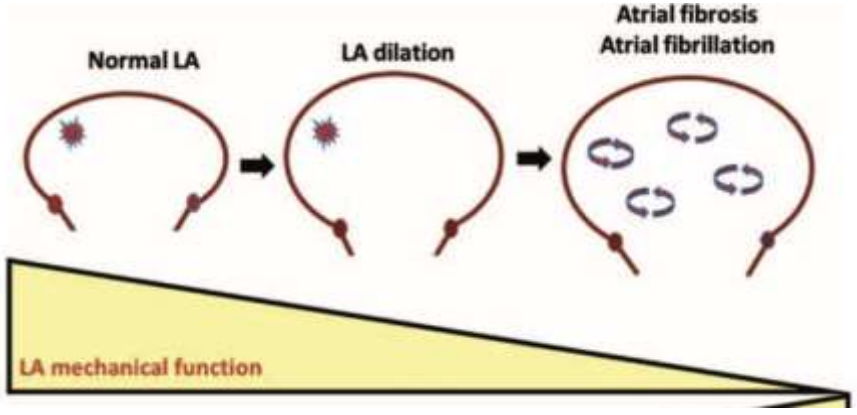
	MR Cohort (n = 53)	Reference Cohort (n = 53)	p Value
LA dimension, cm	4.38 ± 0.56	4.03 ± 0.52	0.001
LAA, cm^2	21.8 ± 5.2	19.2 ± 3.3	0.003
LA volume, cm^3	68.5 ± 29.3	55.2 ± 14.1	0.004
LA volume index, cm^3/m^2	31.8 ± 12.9	26.4 ± 6.6	0.008
Mitral annulus dimension, cm	3.49 ± 0.31	3.23 ± 0.42	0.001
MRJA, cm^2	6.0 ± 2.7	1.2 ± 0.7	<0.0001
MRJA/LAA ratio	0.35 ± 0.11	0.09 ± 0.04	<0.0001
Ejection fraction, %	61.5 ± 7.1	62.2 ± 7.1	0.63
LV end-diastolic dimension, cm	5.01 ± 0.57	4.92 ± 0.49	0.39
LV end-systolic dimension, cm	3.41 ± 0.58	3.25 ± 0.62	0.17
Septal thickness, cm	1.14 ± 0.21	1.09 ± 0.19	0.21
Posterior wall thickness, cm	1.10 ± 0.17	1.06 ± 0.17	0.31

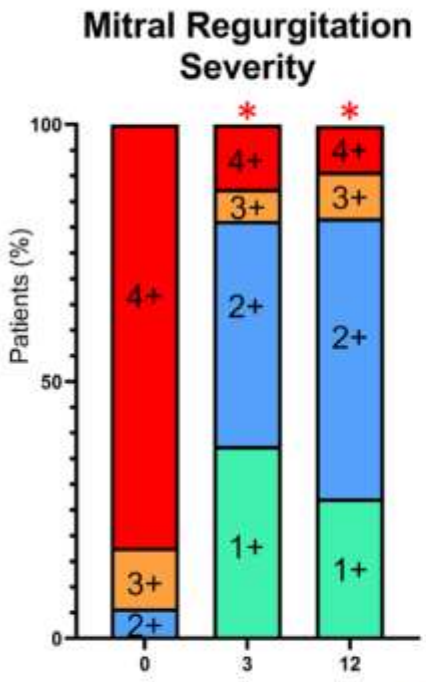


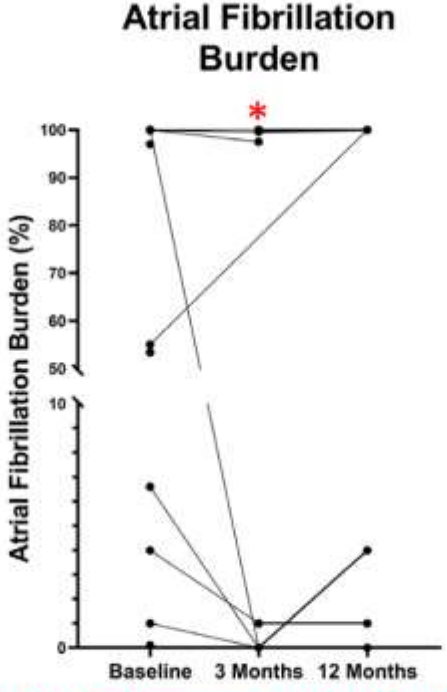
Gertz ZM, et al. J Am Coll Cardiol 2011;58:1474-81

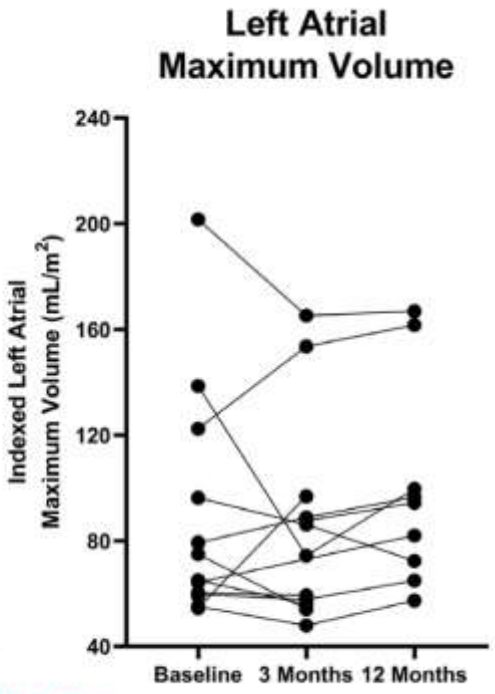
M-TEER and Impact on AF







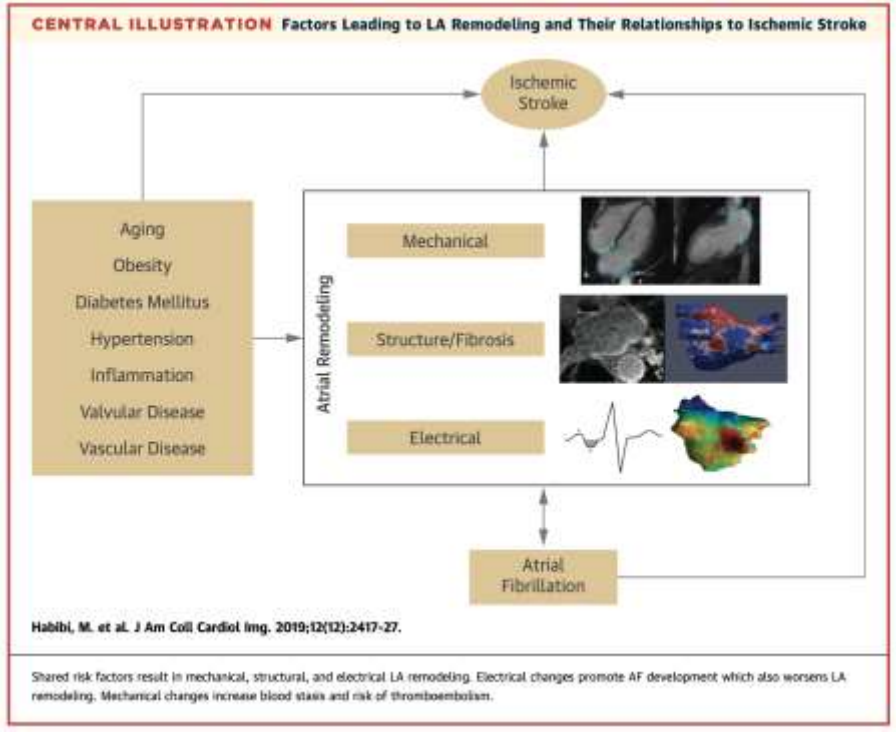


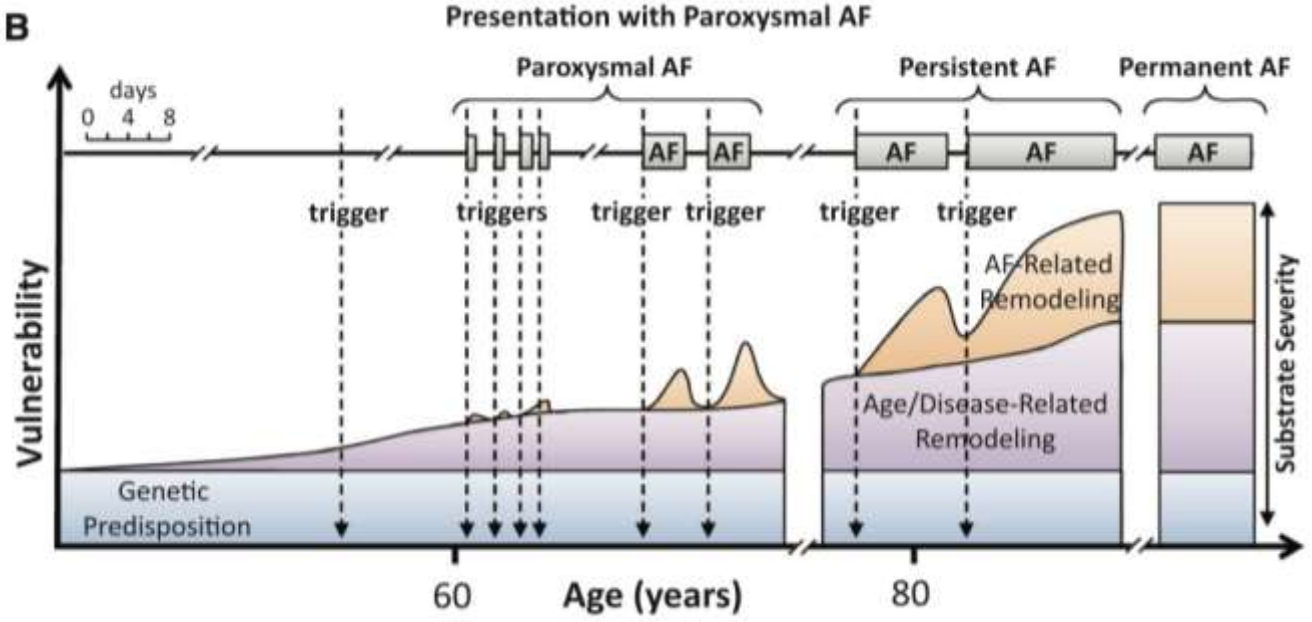


*p<0.05 for comparison to baseline

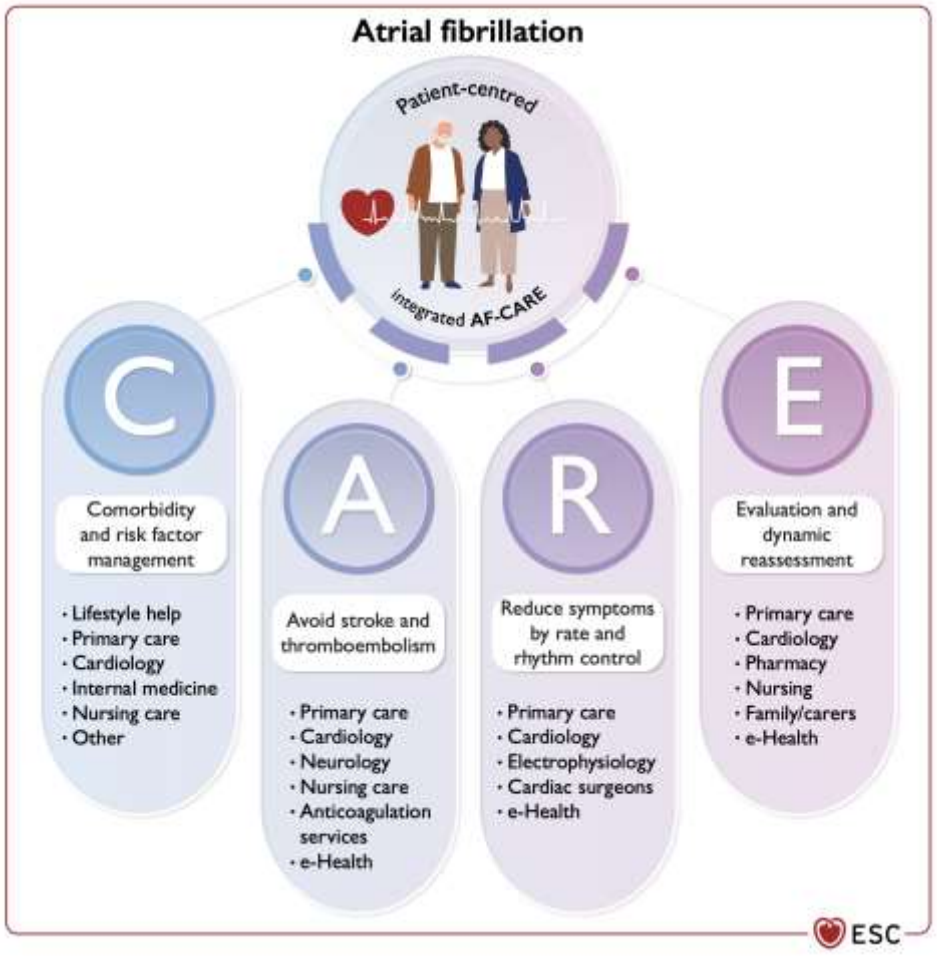
Trankle CR, et al. PACE 2022
Triposkiadis F, et al. Eur J Heart Fail 2016

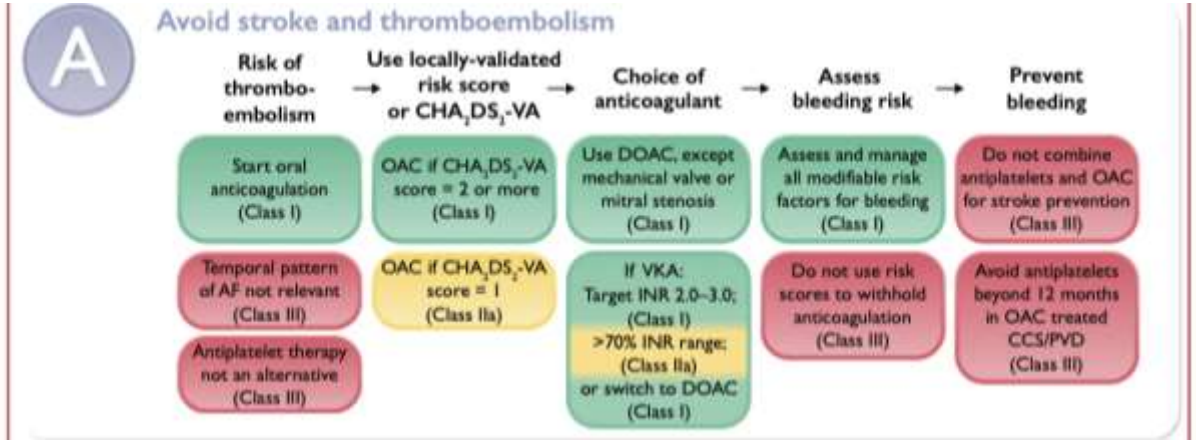
Atrial Cardiomyopathy





Atrial Fibrillation – Latest Guidelines

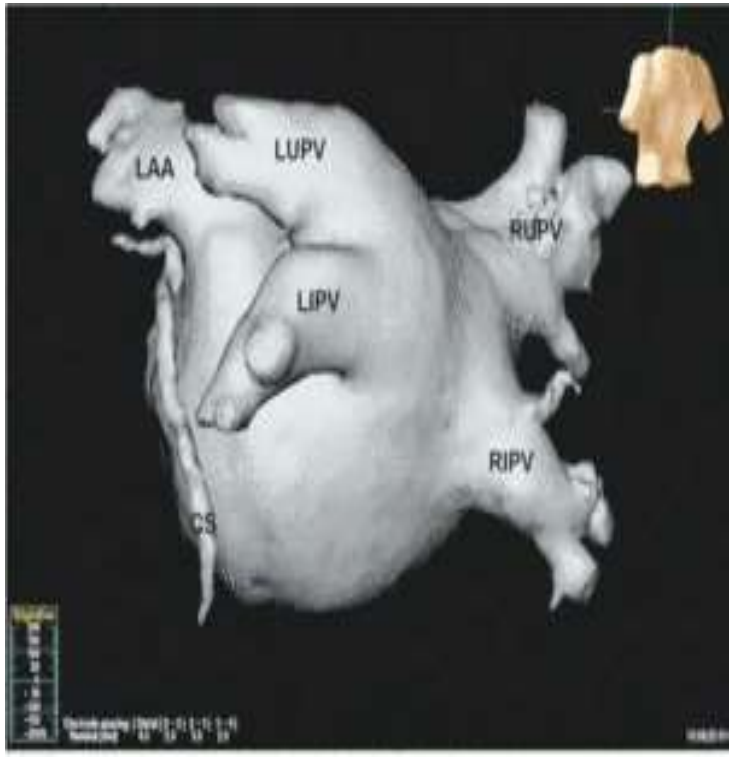




Gelder IC, et al. Eur Heart J 2024

Atrial fibrillation – Left Atrial Appendage

- Embryological Remnant
- Role unclear
- Wall thickness 0.5-2 mm, Volume 17-45ml



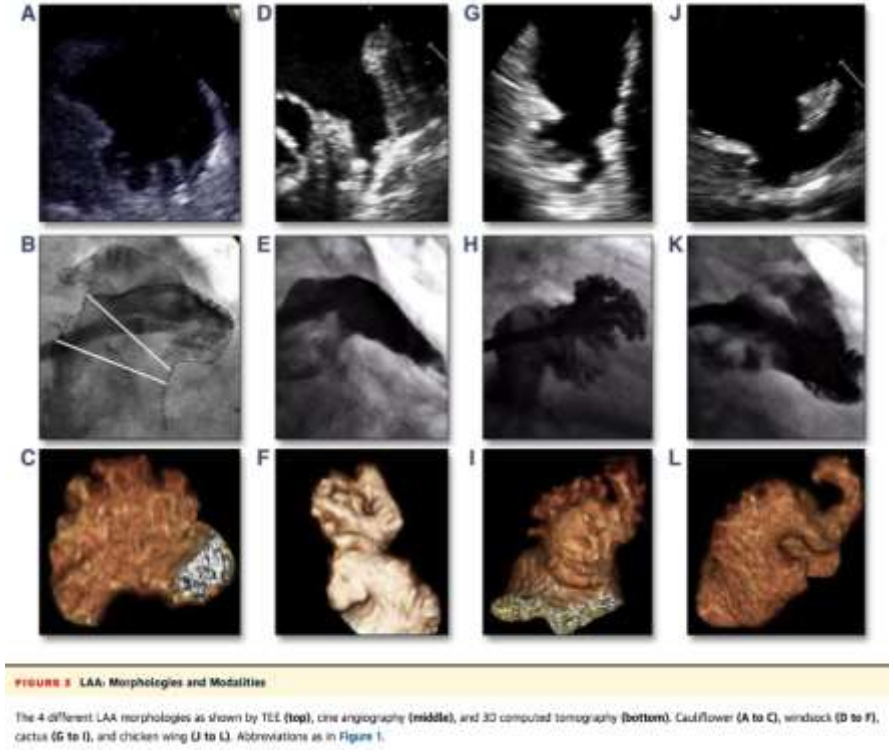


FIGURE 3 LAA: Morphologies and Modalities

The 4 different LAA morphologies as shown by TEE (top), cine angiography (middle), and 3D computed tomography (bottom). Cauliflower (A to C), windsock (D to F), cactus (G to I), and chicken wing (J to L). Abbreviations as in Figure 1.

Beigel R, et al. JACC Cardiovasc Imag 2014
Fastner C,.... Akin I. Clin Cardiol 2017
Fastner C, ... Akin I. EuroIntervention 2018

Anticoagulation

Table 10 Updated definitions for the CHA_2DS_2-VA score

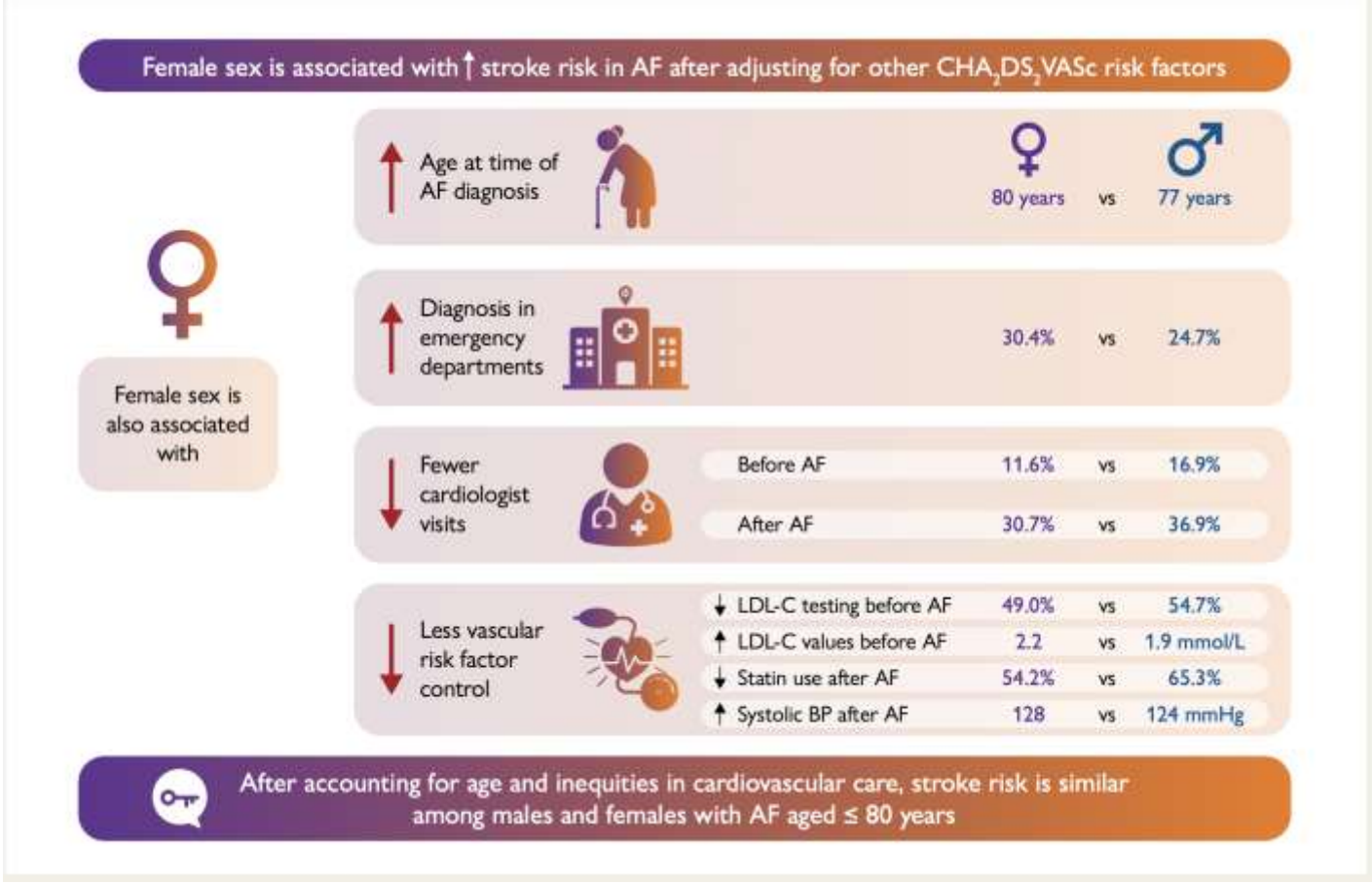
CHA_2DS_2-VA component		Definition and comments	Points awarded[a]
C	Chronic heart failure	Symptoms and signs of heart failure (irrespective of LVEF, thus including HFpEF, HFmrEF, and HFrEF), or the presence of asymptomatic LVEF ≤40%.[261–263]	1
H	Hypertension	Resting blood pressure >140/90 mmHg on at least two occasions, or current antihypertensive treatment. The optimal BP target associated with lowest risk of major cardiovascular events is 120–129/70–79 mmHg (or keep as low as reasonably achievable).[162,264]	1
A	Age 75 years or above	Age is an independent determinant of ischaemic stroke risk.[265] Age-related risk is a continuum, but for reasons of practicality, two points are given for age ≥75 years.	2
D	Diabetes mellitus	Diabetes mellitus (type 1 or type 2), as defined by currently accepted criteria,[266] or treatment with glucose lowering therapy.	1
S	Prior stroke, TIA, or arterial thromboembolism	Previous thromboembolism is associated with highly elevated risk of recurrence and therefore weighted 2 points.	2
V	Vascular disease	Coronary artery disease, including prior myocardial infarction, angina, history of coronary revascularization (surgical or percutaneous), and significant CAD on angiography or cardiac imaging.[267] OR Peripheral vascular disease, including: intermittent claudication, previous revascularization for PVD, percutaneous or surgical intervention on the abdominal aorta, and complex aortic plaque on imaging (defined as features of mobility, ulceration, pedunculation, or thickness ≥4 mm).[268,269]	1
A	Age 65–74 years	1 point is given for age between 65 and 74 years.	1

Risk factor	Score
Congestive heart failure/LV dysfunction	1
Hypertension	1
Age ≥75	2
Diabetes mellitus	1
Stroke/TIA/thrombo-embolism	2
Vascular disease[a]	1
Age 65–74	1
Sex category (i.e. female sex)	1
Maximum score	**9**

Risk category	CHA_2DS_2-VASc score	Recommended antithrombotic therapy
One 'major' risk factor or ≥2 'clinically relevant non-major' risk factors	≥ 2	OAC[a]
One 'clinically relevant non-major' risk factor	1	Either OAC[a] or aspirin 75–325 mg daily. Preferred: OAC rather than aspirin.
No risk factors	0	Either aspirin 75–325 mg daily or no antithrombotic therapy. Preferred: no antithrombotic therapy rather than aspirin.

Gelder IC, et al. Eur Heart J 2024

Gender



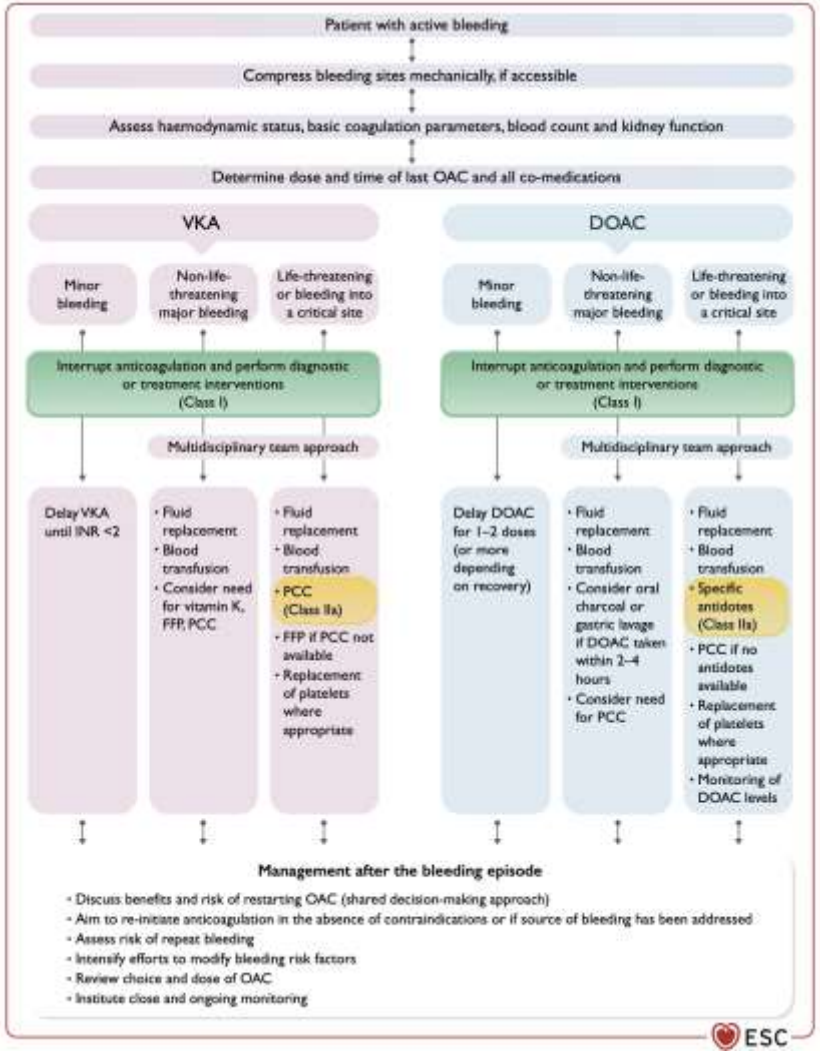
Buhari H, et al. Eur Heart J 2024;45:104-113

Guidelines - A

DOAC	Standard full dose	Criteria for dose reduction	Reduced dose only if criteria met
Apixaban	5 mg twice daily	Two out of three needed for dose reduction: (i) age ≥80 years (ii) body weight ≤60 kg (iii) serum creatinine ≥133 mmol/L.	2.5 mg twice daily
Dabigatran	150 mg twice daily	Dose reduction recommended if any apply: (i) age ≥80 years (ii) receiving concomitant verapamil. Dose reduction considered on an individual basis if any apply: (i) age 75–80 (ii) moderate renal impairment (creatinine clearance 30–50 mL/min) (iii) patients with gastritis, oesophagitis, or gastro-oesophageal reflux (iv) others at increased risk of bleeding.	110 mg twice daily
Edoxaban	60 mg once daily	Dose reduction if any apply: (i) moderate or severe renal impairment (creatinine clearance 15–50 mL/min) (ii) body weight ≤60 kg (iii) concomitant use of ciclosporin, dronedarone, erythromycin, or ketoconazole.	30 mg once daily
Rivaroxaban	20 mg once daily	Creatinine clearance 15–49 mL/min.	15 mg once daily

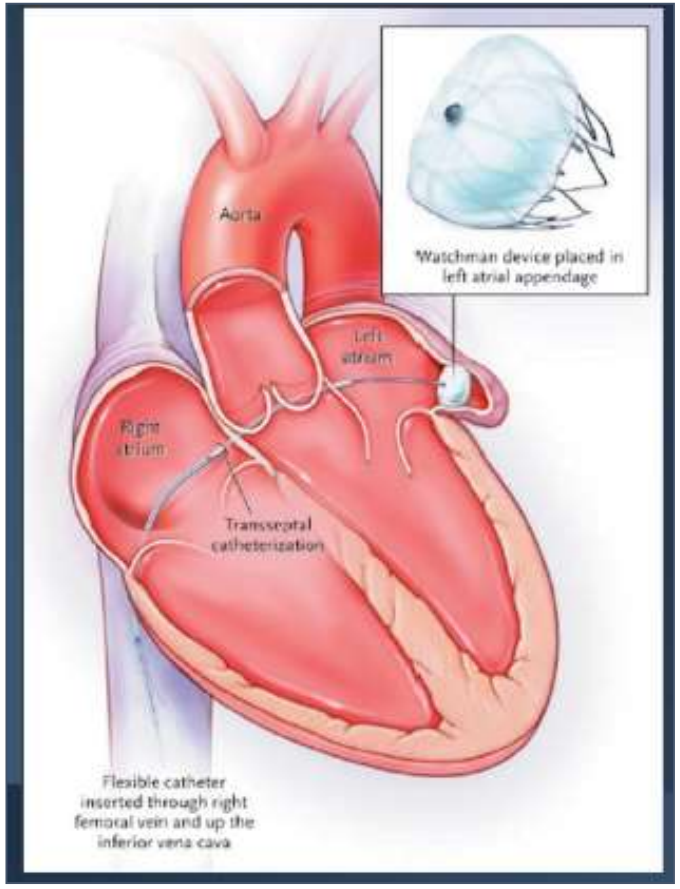
Van Gelder IC, et al. Eur Heart J 2024

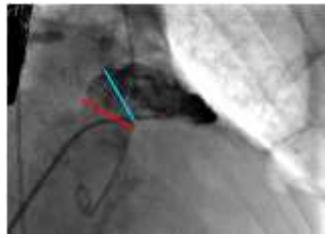
Guidelines - A

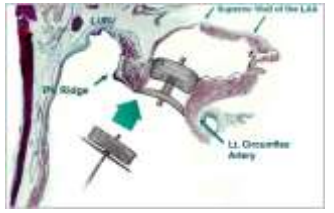


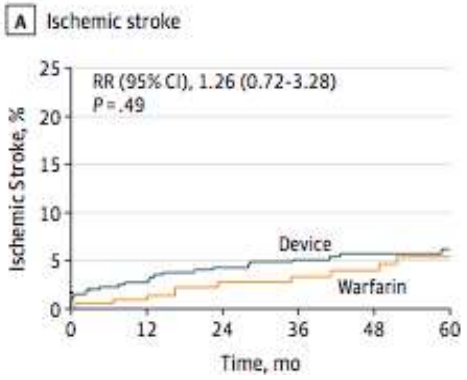
Van Gelder IC, et al. Eur Heart J 2024

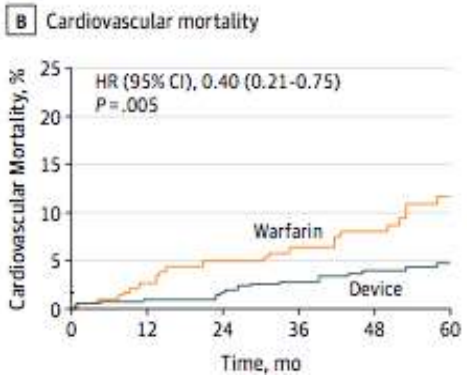
Left Atrial Appendage Occlusion

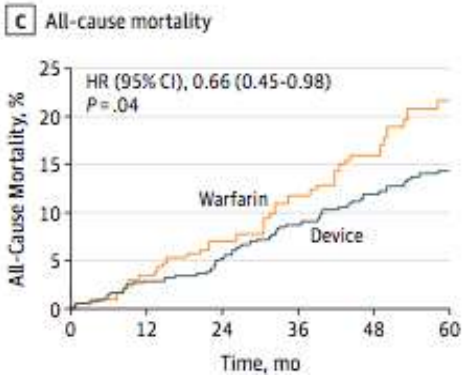








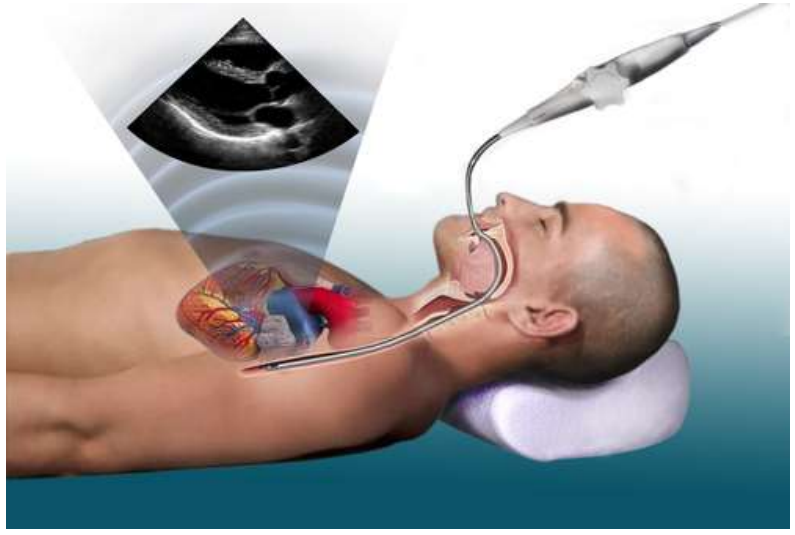


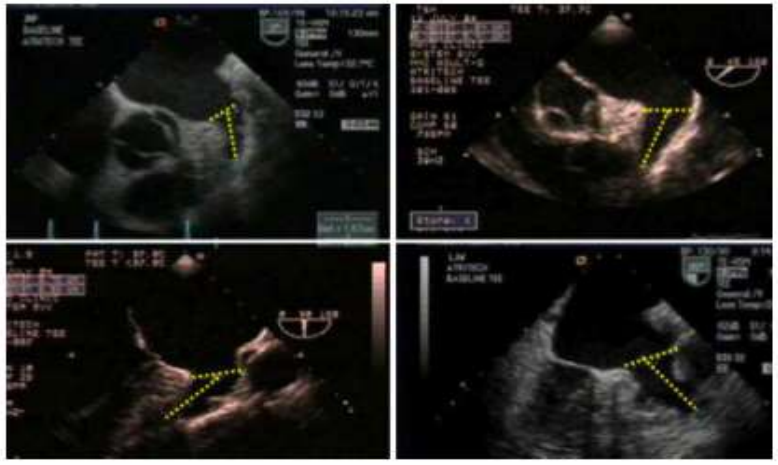


Reddy VY. JAMA 2014;312:1988-1998

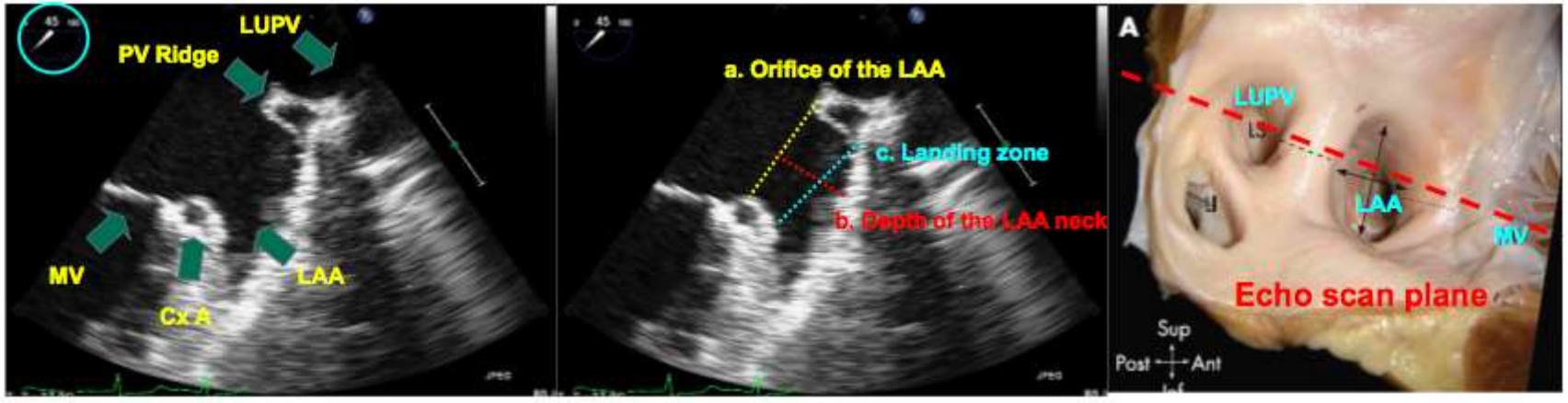
Atrial fibrillation – Left Atrial Appendage Occluder

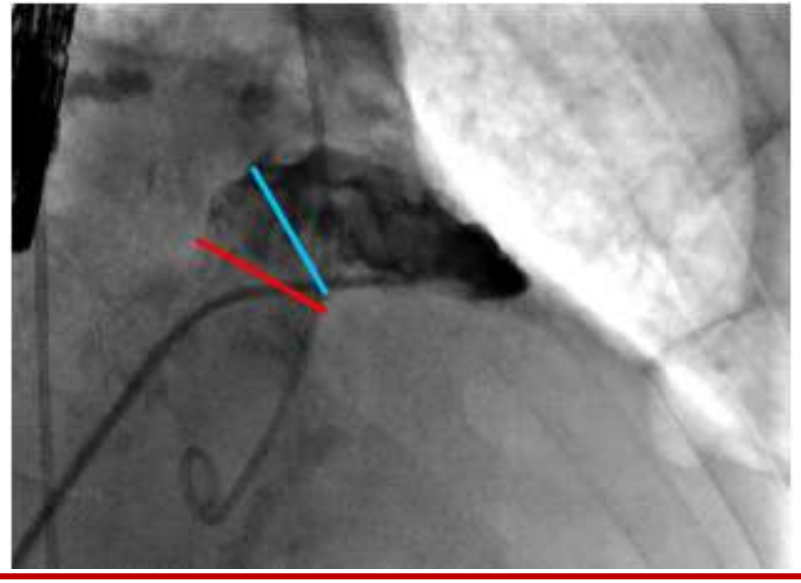
- In cath lab
- Propofol sedation
- Transesophageal echocardiography
- Vena femoralis right
- Heparin (ACT > 250 s)
- Duration nearly 60 Minuten

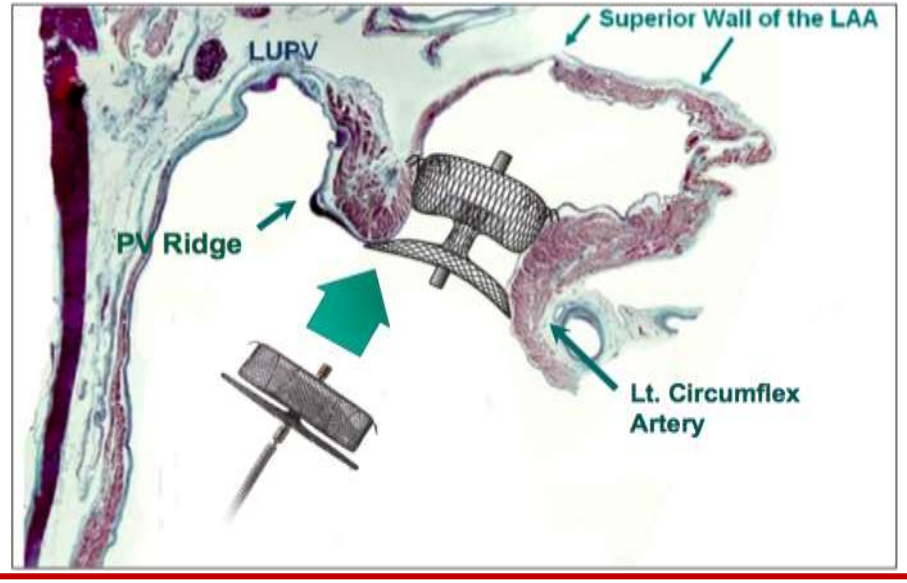




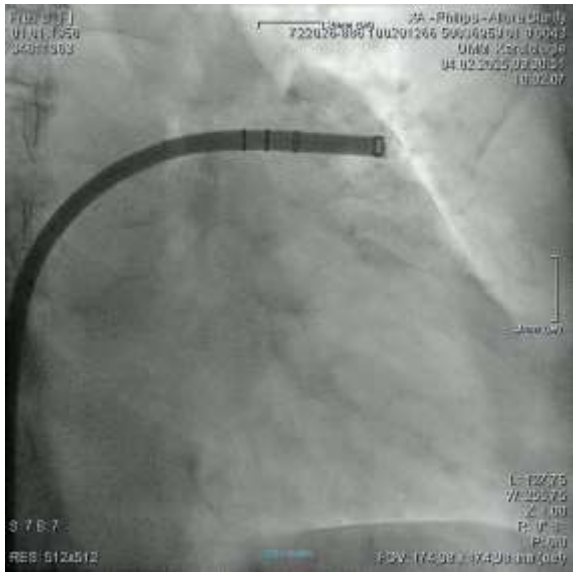
Atrial fibrillation – Left Atrial Appendage Occluder

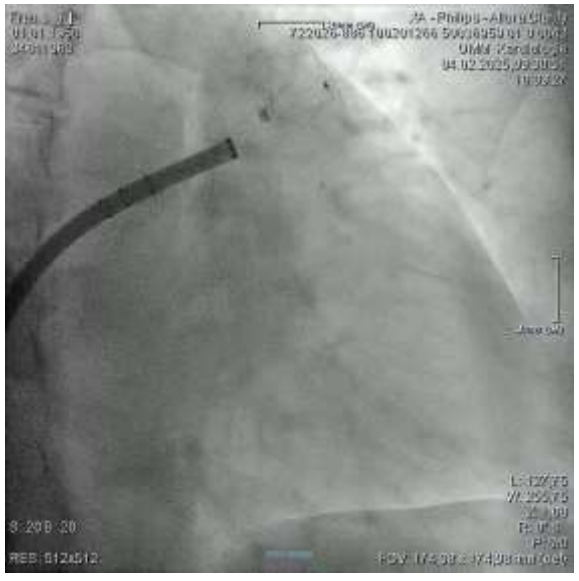


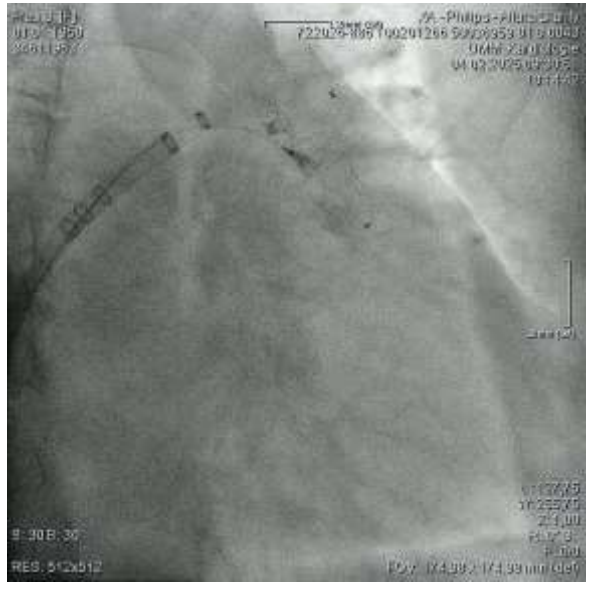


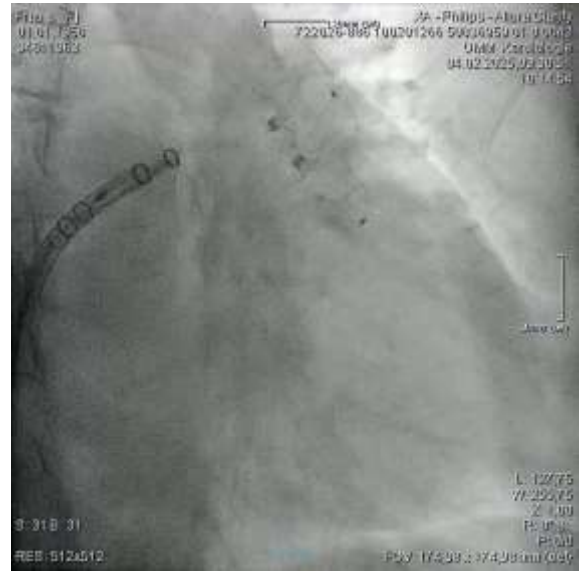


LAAO: Cases for PDL and Large LAA

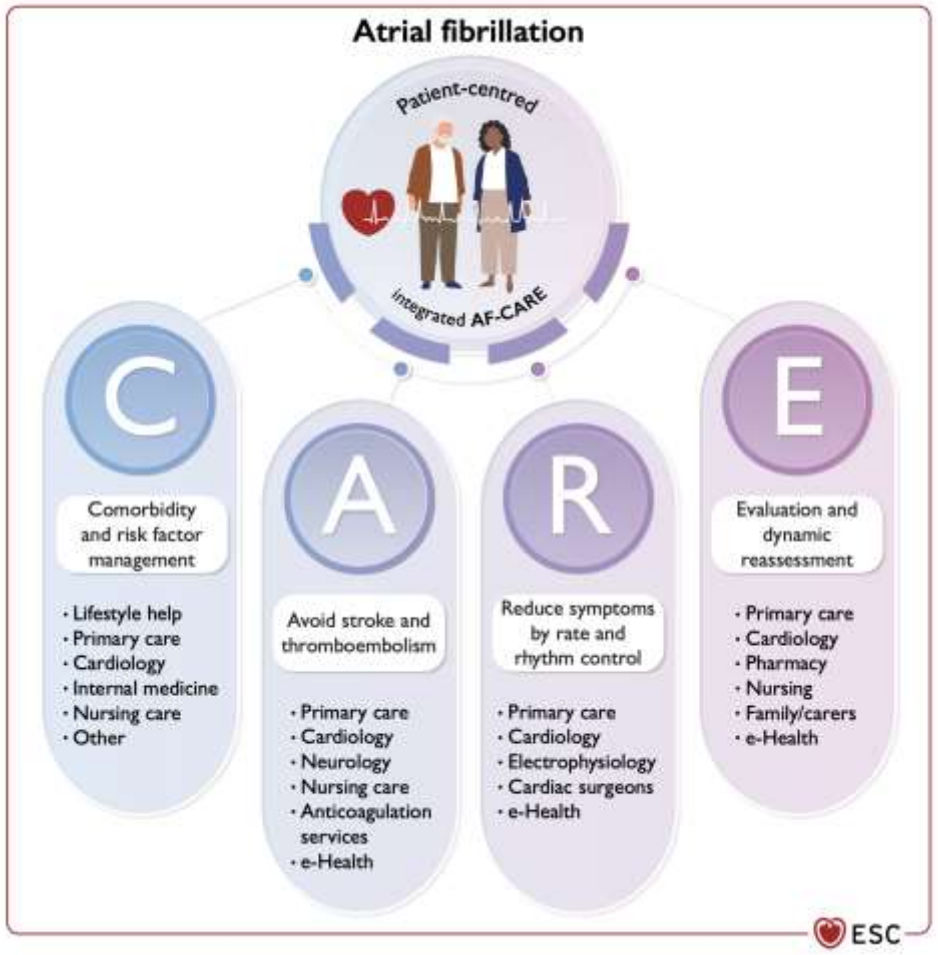


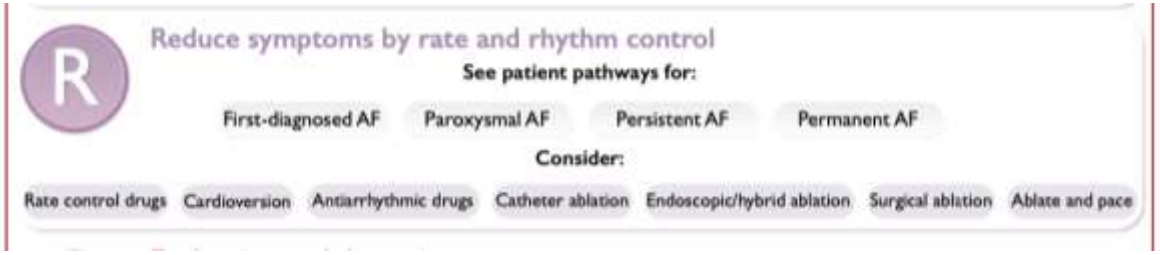






Patient-centered multidisciplinary pathway





Gelder IC, et al. Eur Heart J 2024

Guidelines - R

Agent[a]	Intravenous administration	Usual range for oral maintenance dose	Contraindicated
Beta-blockers[b]			
Metoprolol tartrate	2.5–5 mg bolus over 2 mins; up to 15 mg maximal cumulative dose	25–100 mg twice daily	In case of asthma, non-selective beta-blockers should be avoided. Contraindicated in acute HF and history of severe bronchospasm.
Metoprolol XL (succinate)	N/A	50–200 mg once daily	
Bisoprolol	N/A	1.25–20 mg once daily	
Atenolol[c]	N/A	25–100 mg once daily	
Esmolol	500 µg/kg i.v. bolus over 1 min; followed by 50–300 µg/kg/min	N/A	
Landiolol	100 µg/kg i.v. bolus over 1 min; followed by 10–40 µg/kg/min	N/A	
Nebivolol	N/A	2.5–10 mg once daily	
Carvedilol	N/A	3.125–50 mg twice daily	
Non-dihydropyridine calcium channel antagonists			
Verapamil	2.5–10 mg i.v. bolus over 5 min	40 mg twice daily to 480 mg (extended release) once daily	Contraindicated if LVEF ≤40%. Adapt doses in hepatic and renal impairment.
Diltiazem	0.25 mg/kg i.v. bolus over 5 min, then 5–15 mg/h	60 mg three times daily to 360 mg (extended release) once daily	
Digitalis glycosides			
Digoxin	0.5 mg i.v. bolus (0.75–1.5 mg over 24 h in divided doses)	0.0625–0.25 mg once daily	High plasma levels associated with adverse events. Check renal function before starting digoxin and adapt dose in CKD patients.
Digitoxin	0.4–0.6 mg	0.05–0.1 mg once daily	
Other			
Amiodarone[d]	300 mg i.v. diluted in 250 mL 5% dextrose over 30–60 min (preferably via central venous cannula), followed by 900–1200 mg i.v. over 24 h diluted in 500–1000 mL via a central venous cannula	200 mg once daily after loading Loading: 200 mg three times daily for 4 weeks, then 200 mg daily or less as appropriate (reduce other rate control drugs according to heart rate)	Contraindicated in iodine sensitivity. Serious potential adverse effects (including pulmonary, ophthalmic, hepatic, and thyroid). Consider numerous drug interactions.

Van Gelder IC, et al. Eur Heart J 2024

Guidelines – R (Cardioversion)

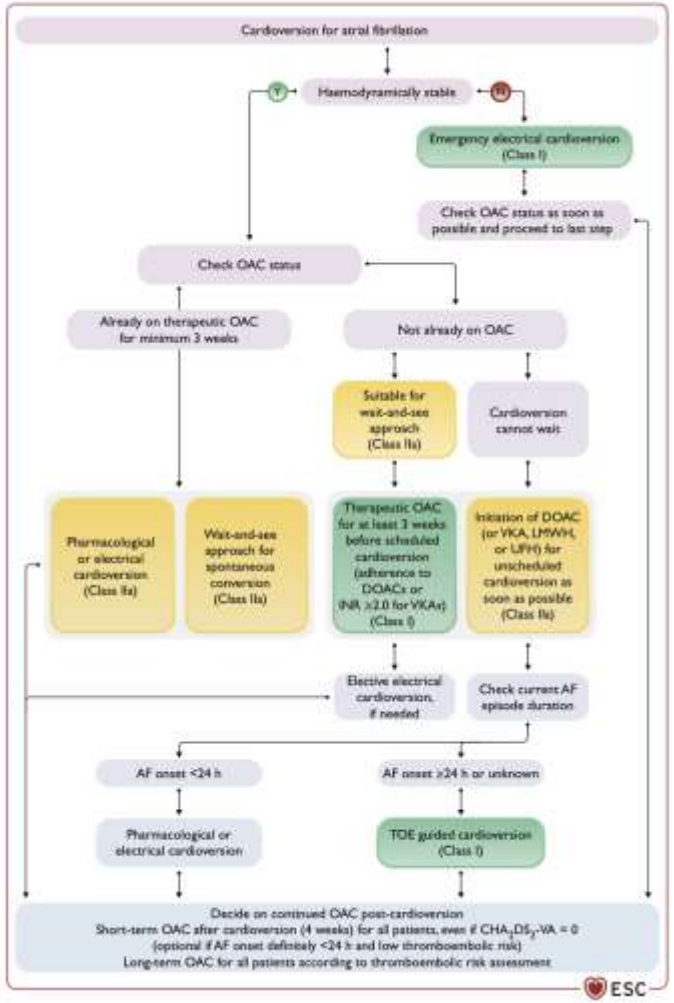


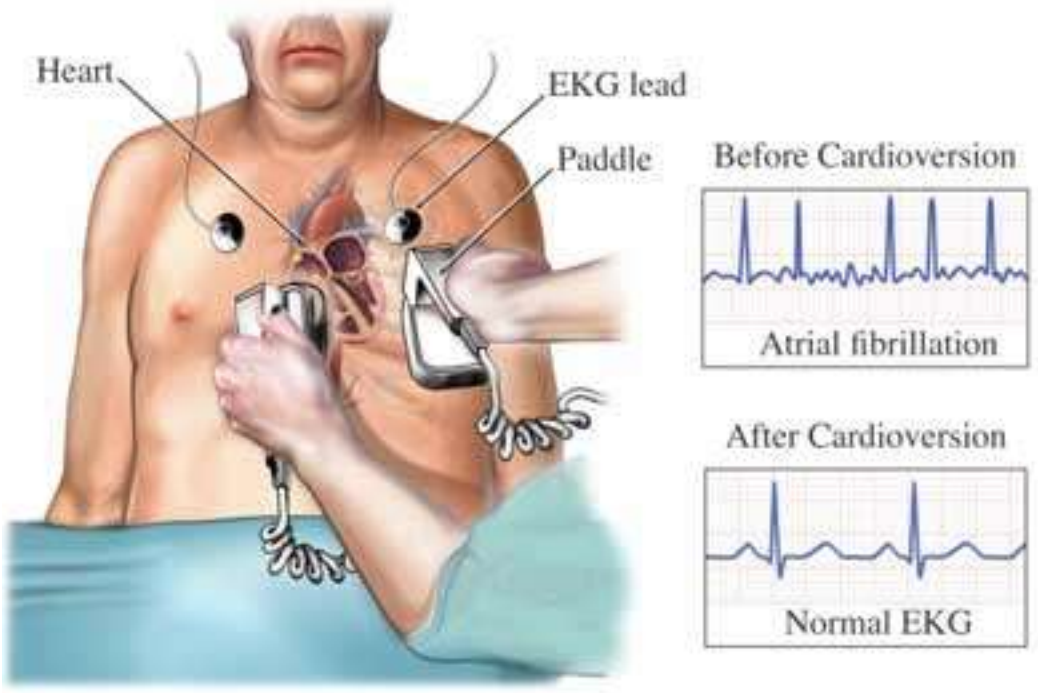
Table 13 Antiarrhythmic drugs for sinus rhythm restoration

Drug	Administration route	Initial dosing	Subsequent dosing [long-term approach]	Acute success rate and time to sinus rhythm	Contraindications and precautions
Flecainide	Oral	200–300 mg	[long-term 50–150 mg twice daily]	50%–60% at 3 h and 75%–85% at 6–8 h (3–8 h)	• Should not be used in patients with severe structural or coronary artery disease, Brugada syndrome, or severe renal failure (CrCl <35 mL/min/1.73 m^2). • Prior documentation of safety and efficacy in an inpatient setting is recommended prior to pill-in-the-pocket use. • An AVN-blocking agent should be administered to avoid 1:1 conduction if transformation to AFL. • Drug infusion should be discontinued in case of QRS widening >25% or bundle branch block occurrence. • Caution is needed in patients with sinus node disease and AVN dysfunction. • Do NOT use for conversion of atrial flutter.
	Intravenous	1–2 mg/kg over 10 min		52%–95% (Up to 6 h)	
Propafenone	Oral	450–600 mg	[long-term 150–300 mg three times daily]	45%–55% at 3 h, 69%–78% at 8 h (3–8 h)	
	Intravenous	1.5–2 mg/kg over 10 min		43%–89% (Up to 6 h)	
Amiodarone	Intravenous (/oral)	300 mg intravenous over 30–60 min	900–1200 mg intravenous over 24 hours (or 200 mg oral three times daily for 4 weeks). [long-term 200 mg oral daily]	44% (8–12 h to several days)	• May cause phlebitis (use a large peripheral vein, avoid i.v. administration >24 h and use preferably volumetric pump). • May cause hypotension, bradycardia/atrioventricular block, QT prolongation. • Only if no other option in patients with hyperthyroidism (risk of thyrotoxicosis). • Consider the broad range of drug interactions.
Ibutilide	Intravenous	1 mg over 10 min (0.01 mg/kg if body weight <60 kg)	1 mg over 10 min (10–20 min after the initial dose)	31%–51% (30–90 min) in AF 60–75% in AFL (60 min)	• Should be used in the setting of a cardiac care unit as it may cause QT prolongation and torsades de pointes. • ECG monitoring for at least 4 h after administration to detect any proarrhythmic effects. • Should not be used in patients with prolonged QT, severe LVH, or low LVEF.
Vernakalant	Intravenous	3 mg/kg over 10 min (maximum 339 mg)	2 mg/kg over 10 min (10–15 min after the initial dose) (maximum 226 mg)	50% within 10 min	• Should not be used in patients with arterial hypotension (SBP <100 mmHg), recent ACS (within 1 month), NYHA III or IV HF, QT prolongation or severe aortic stenosis. • May cause arterial hypotension, QT prolongation, QRS widening, or non-sustained ventricular tachycardia.

Van Gelder IC, et al. Eur Heart J 2024

Rhythm Control Acute - Cardioversion

Recommendations	Class[a]	Level[b]	Ref.[c]
Immediate DCC is recommended when a rapid ventricular rate does not respond promptly to pharmacological measures in patients with AF and ongoing myocardial ischaemia, symptomatic hypotension, angina, or heart failure.	I	C	
Immediate DCC is recommended for patients with AF involving pre-excitation when rapid tachycardia or haemodynamic instability is present.	I	B	82
Elective DCC should be considered in order to initiate a long-term rhythm control management strategy for patients with AF.	IIa	B	46, 78, 83
Pre-treatment with amiodarone, flecainide, propafenone, ibutilide, or sotalol should be considered to enhance success of DCC and prevent recurrent AF.	IIa	B	79–81
Repeated DCC may be considered in highly symptomatic patients refractory to other therapy.	IIb	C	
Pre-treatment with β-blockers, diltiazem or verapamil may be considered for rate control, although the efficacy of these agents in enhancing success of DCC or preventing early recurrence of AF is uncertain.	IIb	C	
DCC is contraindicated in patients with digitalis toxicity.	III	C	



Camm AJ, Eur Heart J 2010;31:2369-2429

EAST AFNET 4 Trial

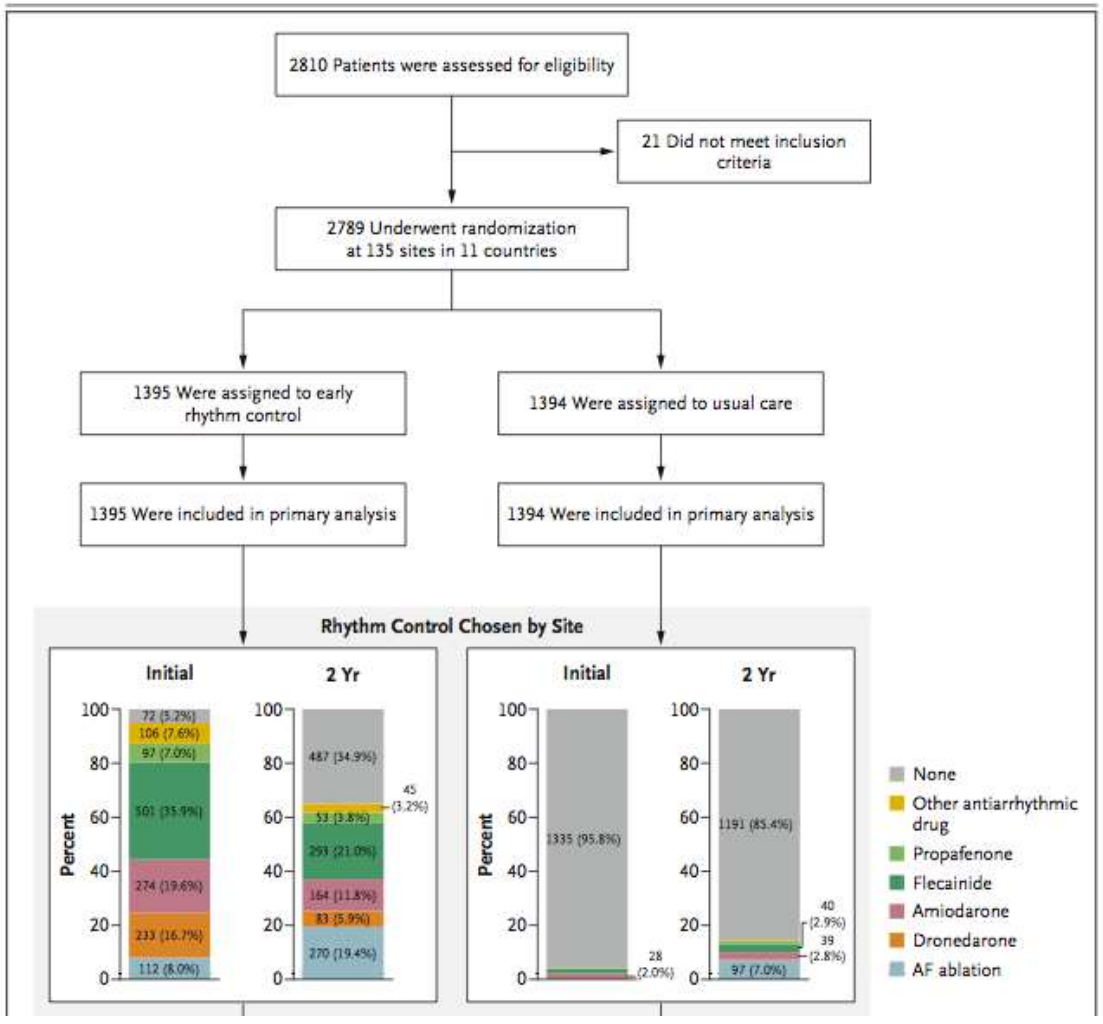
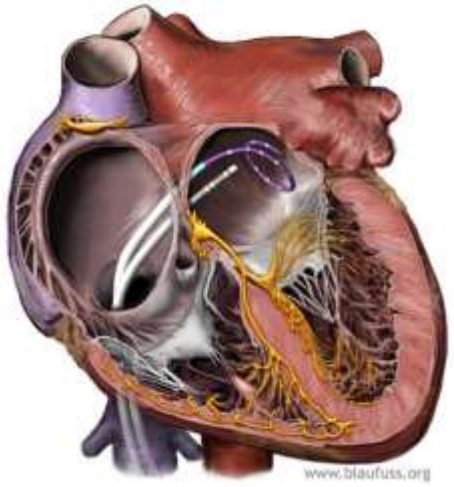


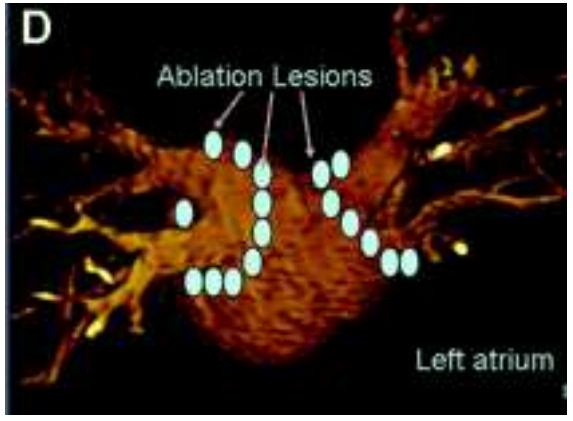
Table 2. Efficacy Outcomes.*

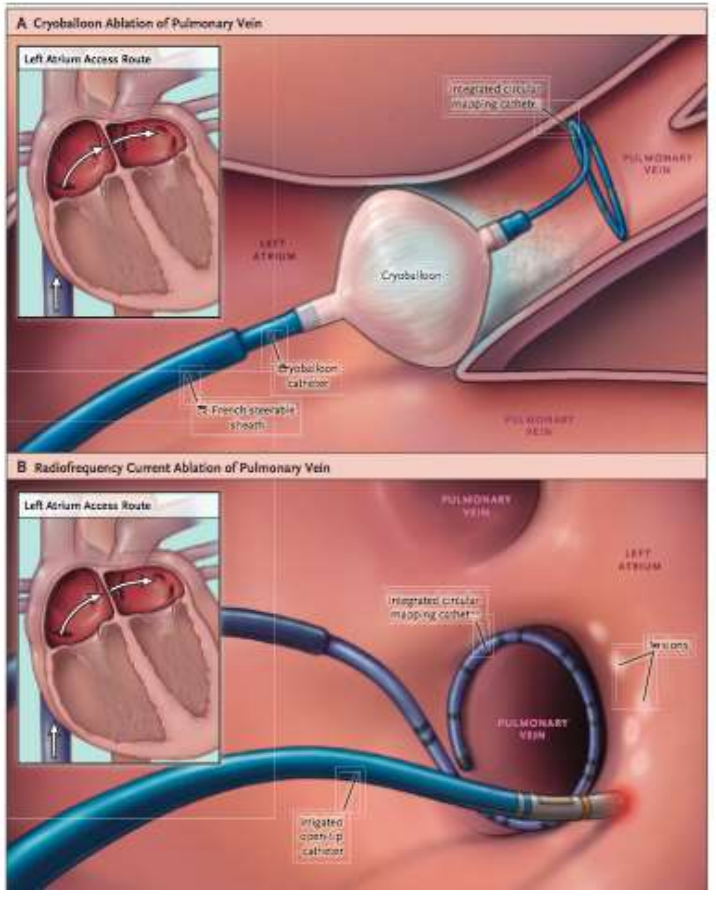
Outcome	Early Rhythm Control	Usual Care	Treatment Effect
First primary outcome — events/person-yr (incidence/100 person-yr)	249/6399 (3.9)	316/6332 (5.0)	0.79 (0.66 to 0.94)†
Components of first primary outcome — events/person-yr (incidence/100 person-yr)			
Death from cardiovascular causes	67/6915 (1.0)	94/6988 (1.3)	0.72 (0.52 to 0.98)‡
Stroke	40/6813 (0.6)	62/6856 (0.9)	0.65 (0.44 to 0.97)‡
Hospitalization with worsening of heart failure	139/6620 (2.1)	169/6558 (2.6)	0.81 (0.65 to 1.02)‡
Hospitalization with acute coronary syndrome	53/6762 (0.8)	65/6816 (1.0)	0.83 (0.58 to 1.19)‡
Second primary outcome — nights spent in hospital/yr	5.8±21.9	5.1±15.5	1.08 (0.92 to 1.28)§
Key secondary outcomes at 2 yr			
Change in left ventricular ejection fraction — %	1.5±9.8	0.8±9.8	0.23 (−0.46 to −0.91)¶
Change in EQ-5D score‖	−1.0±21.4	−2.7±22.3	1.07 (−0.68 to 2.82)¶
Change in SF-12 Mental Score**	0.7±10.6	1.6±10.1	−1.20 (−2.04 to −0.37)¶
Change in SF-12 Physical Score**	0.3±8.5	0.1±8.2	0.33 (−0.39 to 1.06)¶
Change in MoCA score	0.1±3.3	0.1±3.2	−0.14 (−0.39 to 0.12)¶
Sinus rhythm — no. of patients with feature/total no. (%)	921/1122 (82.1)	687/1135 (60.5)	3.13 (2.55 to 3.84)††
Asymptomatic — no. of patients with feature/total no. (%)‡‡	861/1159 (74.3)	850/1171 (72.6)	1.14 (0.93 to 1.40)††

Kirchhof P, et al N Engl J Med 2020

Clinical Impact of Atrial Cardiomyopathy on AF Recurrence after PVI



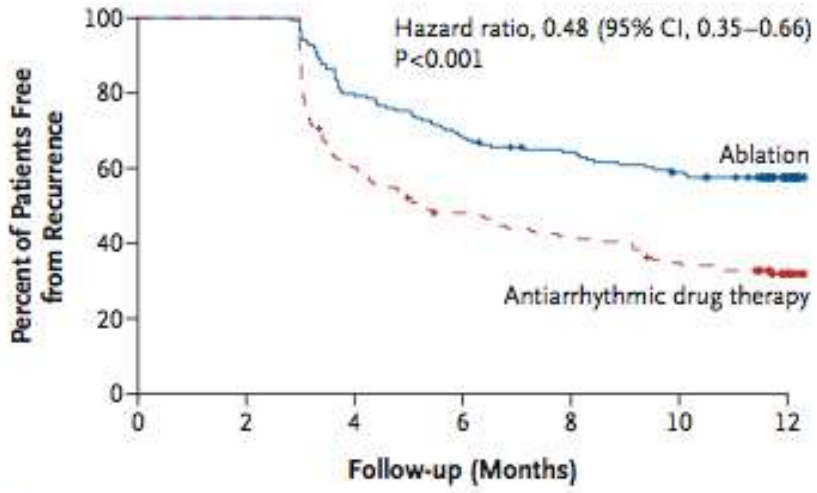




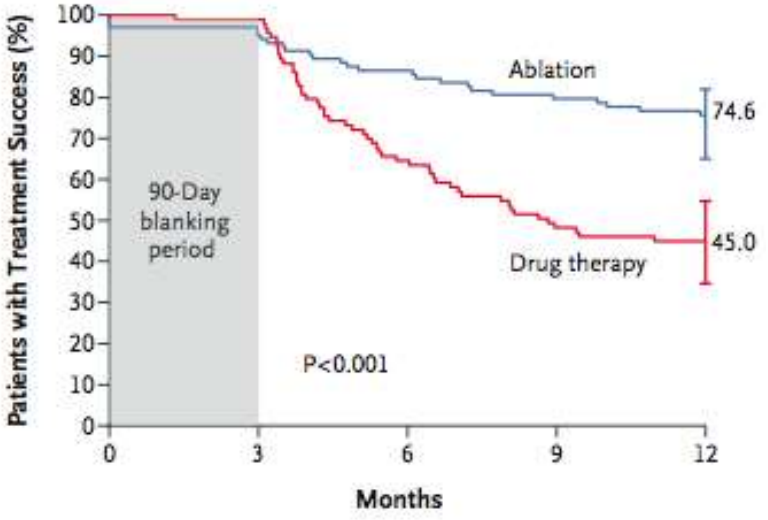
Masuda M, et al. Haert Rhythm 2024;21:378-86

Kuck KH, et al. NEJM 2019

EARLY AF Trial and STOP AF Trial



No. at Risk							
Ablation	154	154	123	105	96	86	55
Antiarrhythmic drug therapy	149	149	89	69	60	49	27



No. at Risk					
Ablation	104	99	88	81	70
Drug therapy	99	93	60	44	39

Andrade JG, et al N Engl J Med 2021
Wazni OM, et al N Engl J Med 2021

Early PVI and Impact on AF Progression (EARLY-AF)

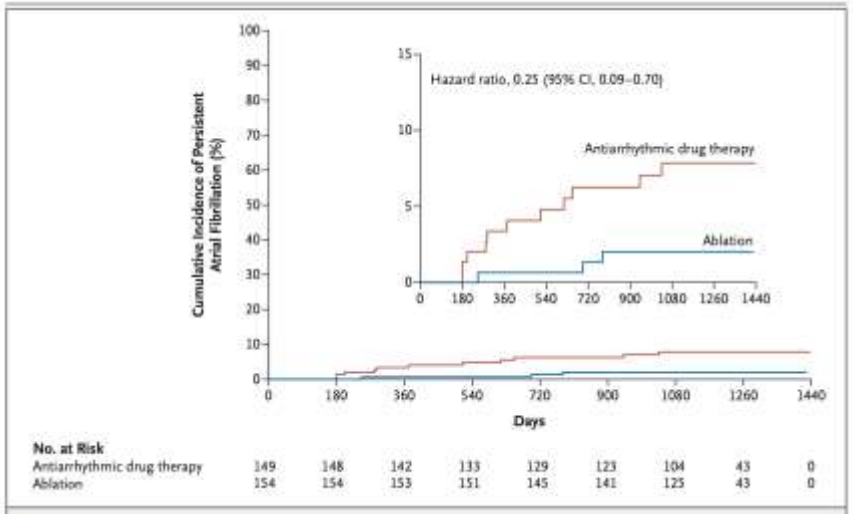


Table 1. Main End Points of Interest.*

End Point	Ablation Group (N=154)	Antiarrhythmic Drug Group (N=149)	Hazard Ratio (95% CI)
	number (percent)		
Progression to persistent atrial fibrillation from 91 days after treatment initiation to final follow-up	3 (1.9)	11 (7.4)	0.25 (0.09–0.70)
Recurrence of any atrial tachyarrhythmia			
From 91 days to 12 mo after treatment initiation†	66 (42.9)	101 (67.8)	0.48 (0.35–0.66)
From 91 days to 36 mo after treatment initiation	87 (56.5)	115 (77.2)	0.51 (0.38–0.67)
Hospitalization			
No. of patients with event (%)	8 (5.2)	25 (16.8)	0.31 (0.14–0.66)
No. of events	9	29	
Median no. of events per patient among those with an event (IQR)	1 (1–1)	1 (1–1)	

Patient with paroxysmal AF

Catheter ablation[a] (Class I)

Patient with persistent AF

Catheter ablation[a] (Class IIb)

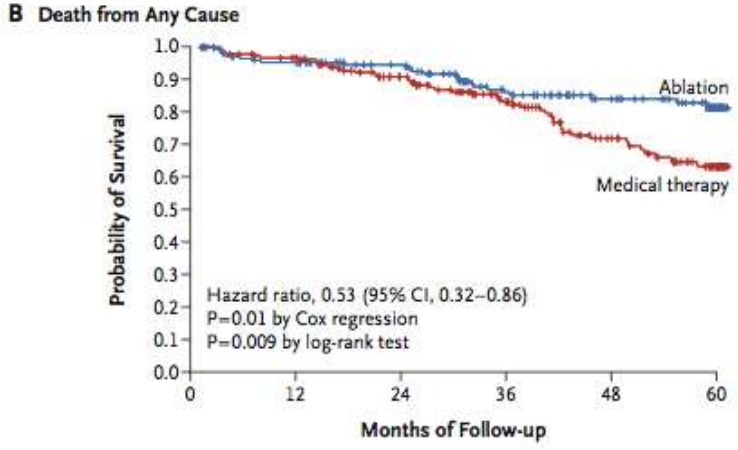
Patient with permanent AF

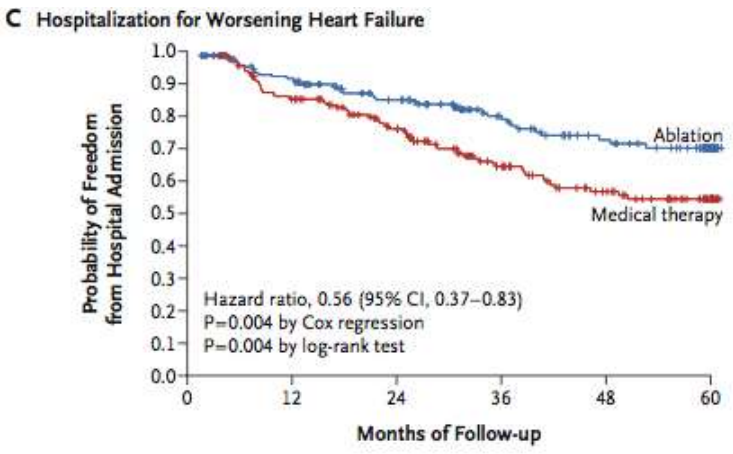
Rate control target = resting heart rate <110 b.p.m. (lenient control), with stricter control with continuing symptoms (Class IIa)

Atrioventricular node ablation and CRT (Class IIa)

Andrade LG, et al. N Engl J Med 2023
Van Gelder, et al. Eur Heart J 2024

PVI in HFrEF (CASTLE AF)





Improved:

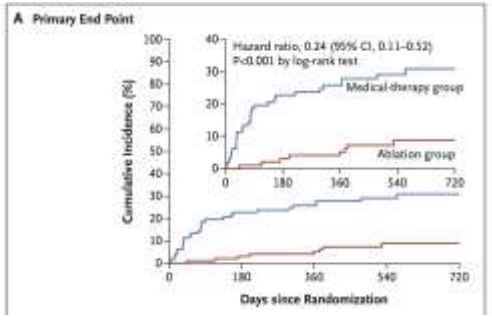
EF (8%)
6-MWT

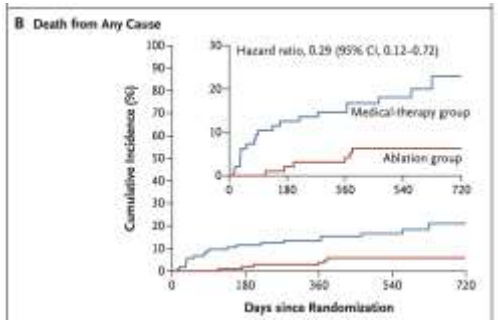
Table 2. Primary and Secondary Clinical End Points.*

End Point	Ablation (N = 179)	Medical Therapy (N = 184)	Hazard Ratio (95% CI)	P Value	
				Cox Regression	Log-Rank Test
	number (percent)				
Primary†	51 (28.5)	82 (44.6)	0.62 (0.43–0.87)	0.007	0.006
Secondary					
Death from any cause	24 (13.4)	46 (25.0)	0.53 (0.32–0.86)	0.01	0.009
Heart-failure hospitalization	37 (20.7)	66 (35.9)	0.56 (0.37–0.83)	0.004	0.004
Cardiovascular death	20 (11.2)	41 (22.3)	0.49 (0.29–0.84)	0.009	0.008
Cardiovascular hospitalization	64 (35.8)	89 (48.4)	0.72 (0.52–0.99)	0.04	0.04
Hospitalization for any cause	114 (63.7)	122 (66.3)	0.99 (0.77–1.28)	0.96	0.96
Cerebrovascular accident	5 (2.8)	11 (6.0)	0.46 (0.16–1.33)	0.15	0.14

Marrouche NF et al. *N Engl J Med* 2018

PVI in HFrEF (CASTLE HTX)





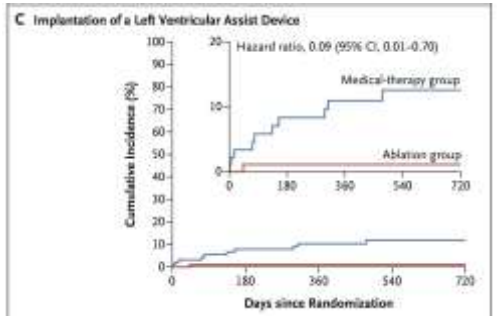
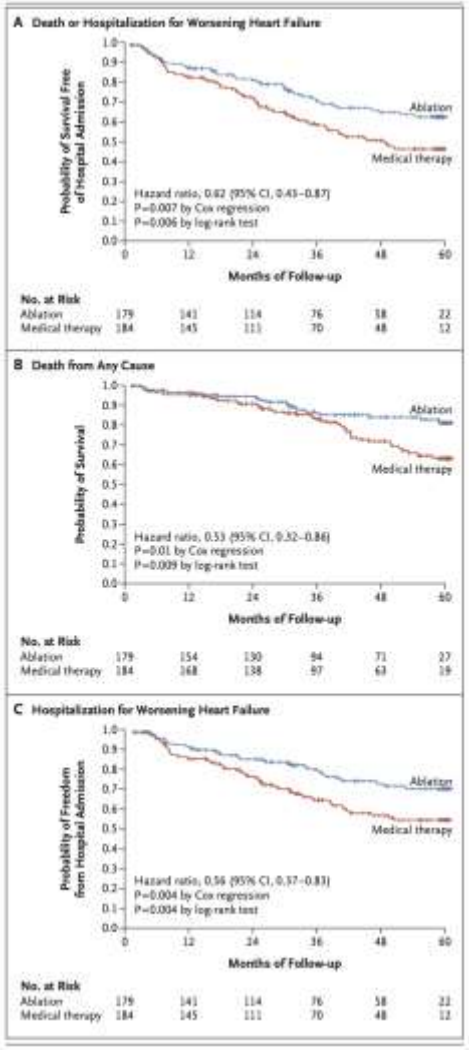


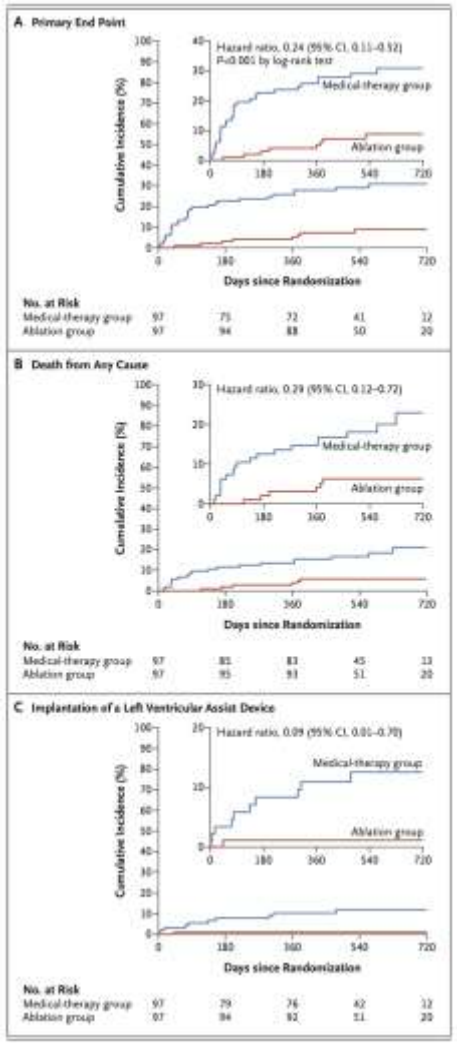
Table 3. Additional End Points.*

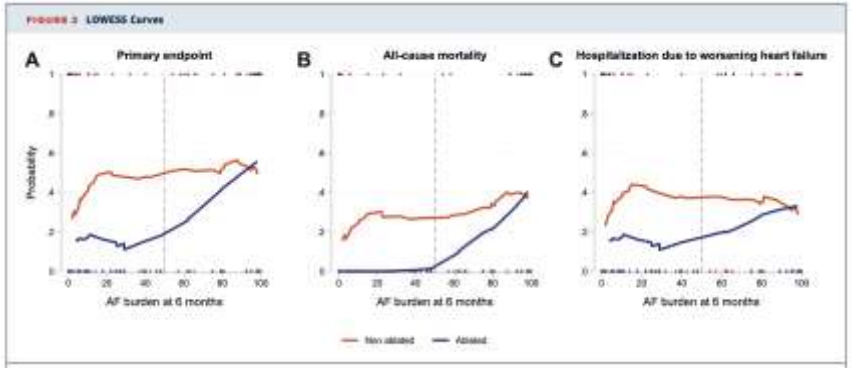
End Point	Ablation Group	Medical-Therapy Group	Mean Between-Group Difference (95% CI)†
Left ventricular ejection fraction			
At baseline			
No. of patients evaluated	97	97	
Value — %	29.0±6.4	27.7±6.3	
At 6 mo			
No. of patients evaluated	92	74	
Baseline value — %	29.4±6.2	28.7±5.9	
Value at 6 mo — %	36.2±8.7	29.9±7.1	
Improvement — percentage points	6.7±6.5	1.2±6.4	5.5 (3.5 to 7.5)
At 12 mo			
No. of patients evaluated	92	70	
Baseline value — %	29.4±6.2	28.7±6.0	
Value at 12 mo — %	37.2±9.1	30.1±8.0	
Improvement — percentage points	7.8±7.6	1.4±7.2	6.4 (4.1 to 8.7)
Atrial fibrillation burden			
At baseline			
No. of patients evaluated	97	97	
Value — %	50.2±31.9	49.3±34.4	
At 6 mo			
No. of patients evaluated	90	71	
Baseline value — %	50.8±31.0	50.7±34.7	
Value at 6 mo — %	20.0±28.3	42.4±35.2	
Reduction — percentage points	30.8±33.3	8.3±25.2	22.5 (13.1 to 31.9)
At 12 mo			
No. of patients evaluated	89	66	
Baseline value — %	50.9±31.2	52.4±35.2	
Value at 12 mo — %	19.6±28.0	43.7±36.2	
Reduction — percentage points	31.4±33.3	8.6±26.3	22.7 (13.0 to 32.5)

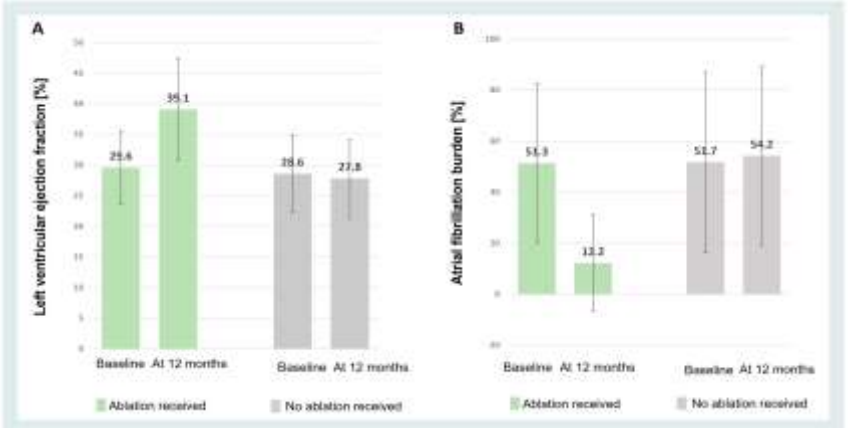
Sohns C, et al. N Engl J Med 2023

Ablation in HFrEF - CASTLE AF / CASTLE HTX



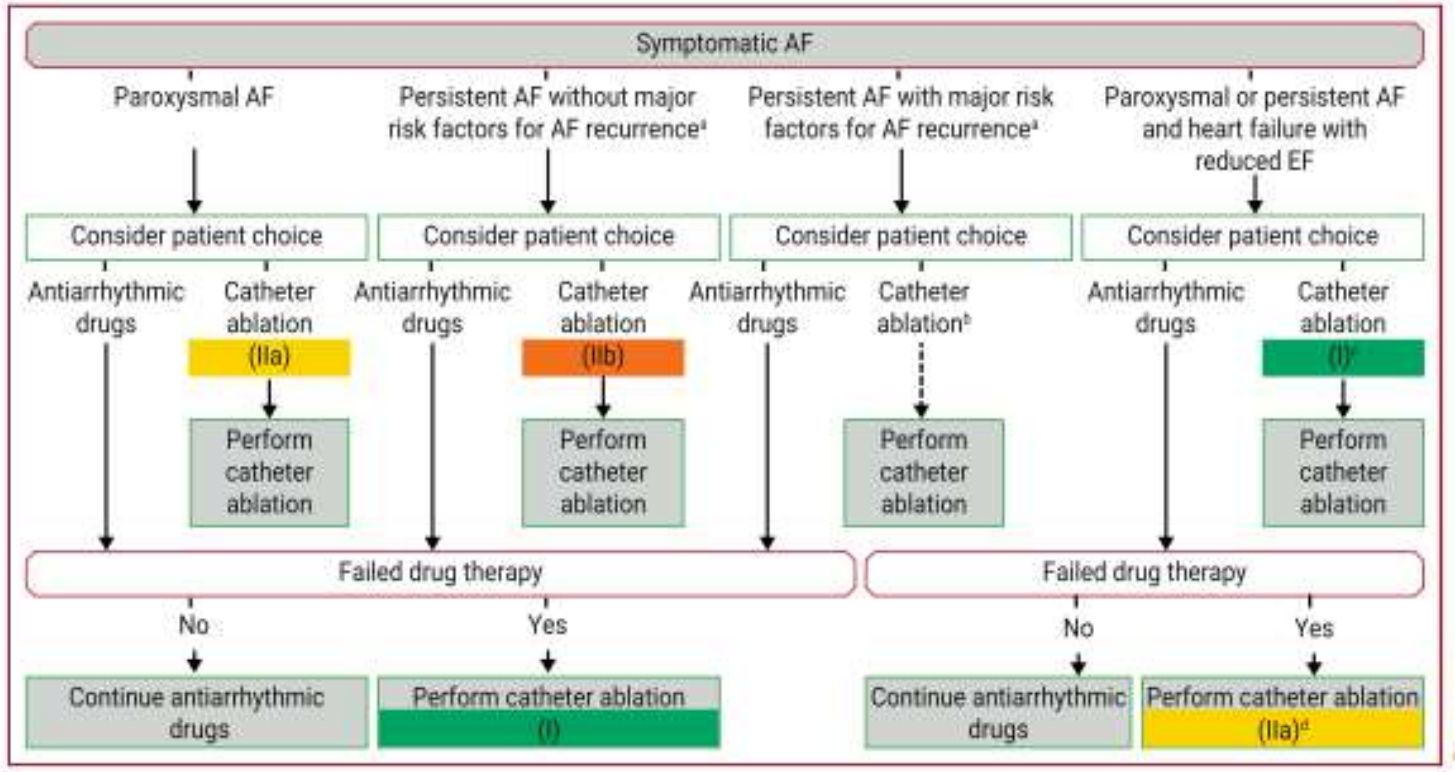






Marrouche NF, et al. N Engl J Med 2018;378:417-27
Brachmann J, et al. JACC EP 2021;7:594-603
Sohns C, et al. Circ EP 2023;389:1380-9
Sohns C, et al. N Engl J Med 2023;389:1380-9

Guidelines in HF and AF



Recommendations	Class[a]	Level[b]
Rhythm control therapy is recommended for symptom and QoL improvement in symptomatic patients with AF.[551–553]	I	A

Hindricks G, et al. Eur Heart J 2020

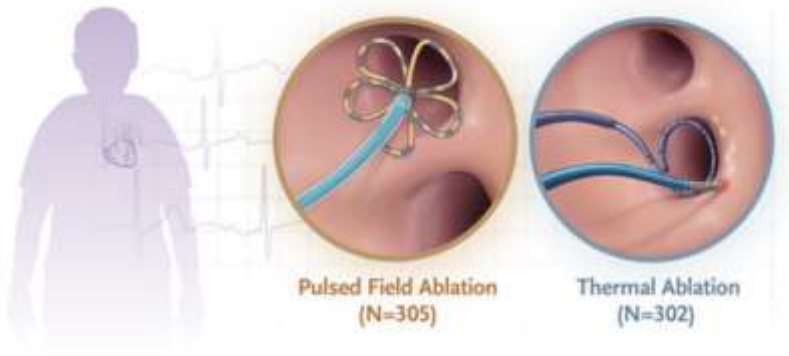
Patient-centered multidisciplinary pathway

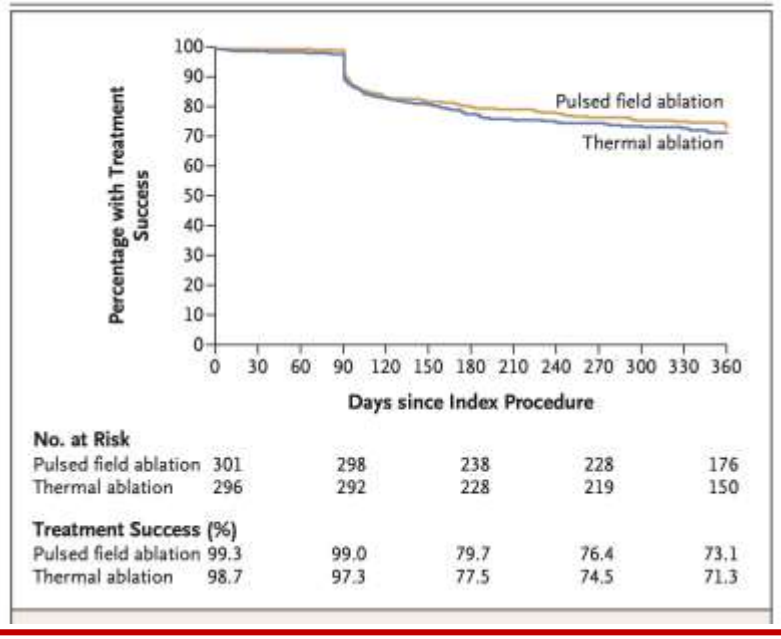
Gelder IC, et al. Eur Heart J 2024

ADVENT Trial

Table 1. Characteristics of the Patients at Baseline.*

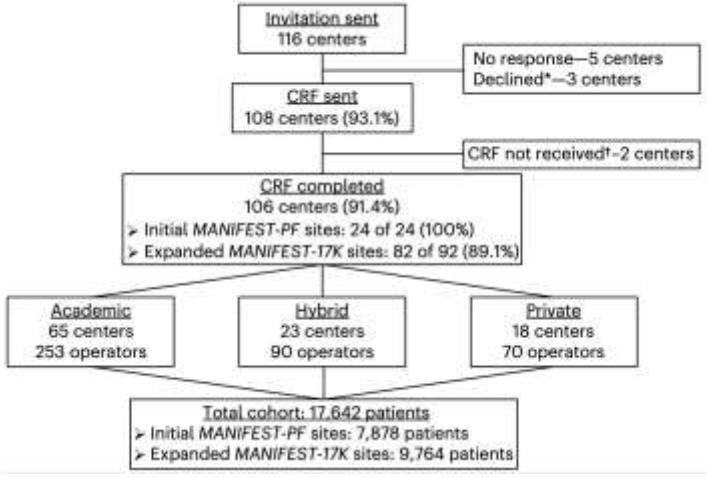
Characteristic	Pulsed Field Ablation (N = 305)	Thermal Ablation (N = 302)†
Age — yr	62.4±8.7	62.5±8.5
Sex — no. (%)		
Male	202 (66.2)	195 (64.6)
Female	103 (33.8)	107 (35.4)
Body-mass index‡	28.3±4.6	29.0±4.8
Race or ethnic group — no. (%)§		
American Indian or Alaska Native	0	1 (0.3)
Asian	6 (2.0)	5 (1.7)
Black	4 (1.3)	11 (3.6)
Native Hawaiian or other Pacific Islander	1 (0.3)	2 (0.7)
White	286 (93.8)	272 (90.1)
Unknown or declined to disclose	8 (2.6)	11 (3.6)
CHA_2DS_2-VASc score¶	1.7±1.2	1.7±1.2
Concomitant clinical conditions — no. (%)		
Coronary artery disease	32 (10.5)	51 (16.9)
Congestive heart failure: NYHA class I or II	59 (19.3)	59 (19.5)
Diabetes	33 (10.8)	32 (10.6)
Dyslipidemia	133 (43.6)	141 (46.7)
Hypertension	174 (57.0)	159 (52.6)
Sleep apnea	81 (26.6)	88 (29.1)
Previous stroke or TIA	12 (3.9)	15 (5.0)
Years since first diagnosis of paroxysmal atrial fibrillation	3.8±6.2	3.3±4.5
Any antiarrhythmic drug at baseline — no. (%)‖	301 (98.7)	300 (99.3)
Class I	115 (37.7)	101 (33.4)
Class II**	174 (57.0)	201 (66.6)
Class III	70 (23.0)	72 (23.8)
Class IV	79 (25.9)	66 (21.9)
Any anticoagulant — no. (%)	305 (100)	301 (99.7)
Nonwarfarin oral anticoagulant	303 (99.3)	300 (99.3)
Vitamin K antagonist	2 (0.7)	1 (0.3)



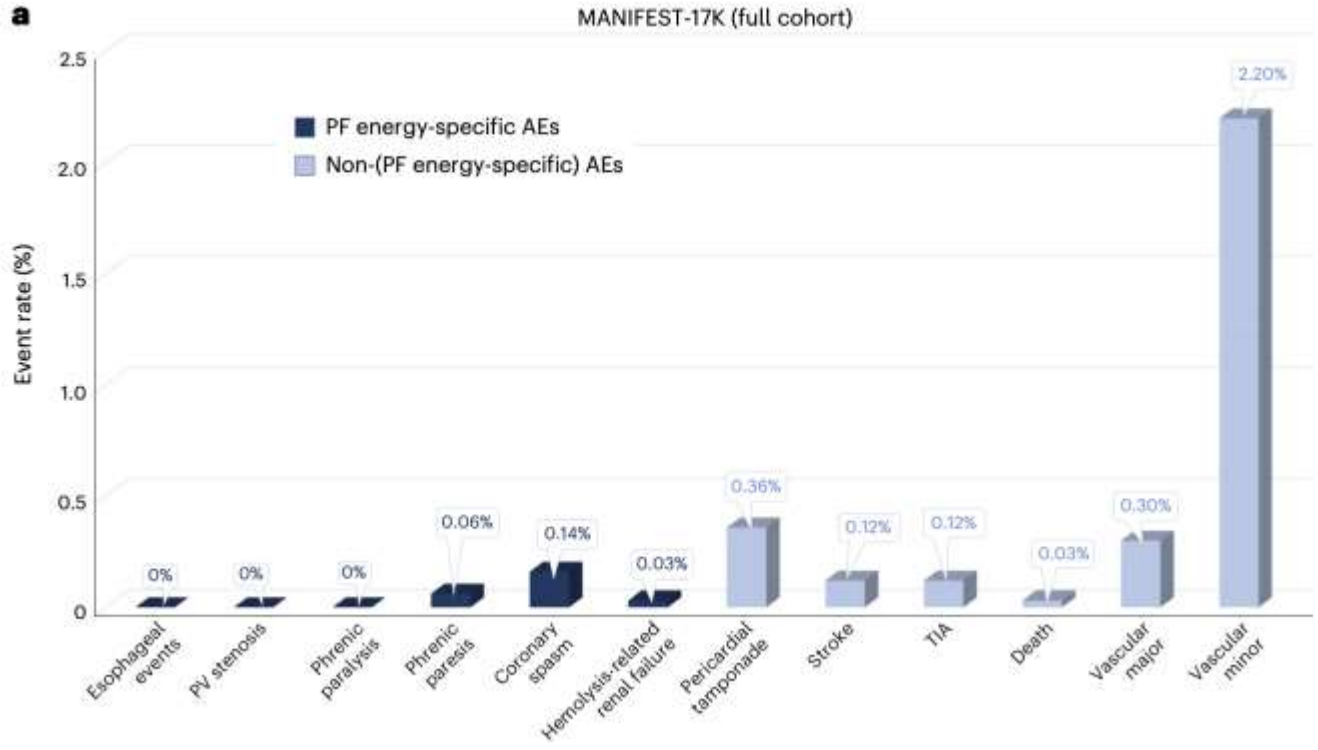


Reddy VY, et al. NEJM 2023

MANIFEST-17K

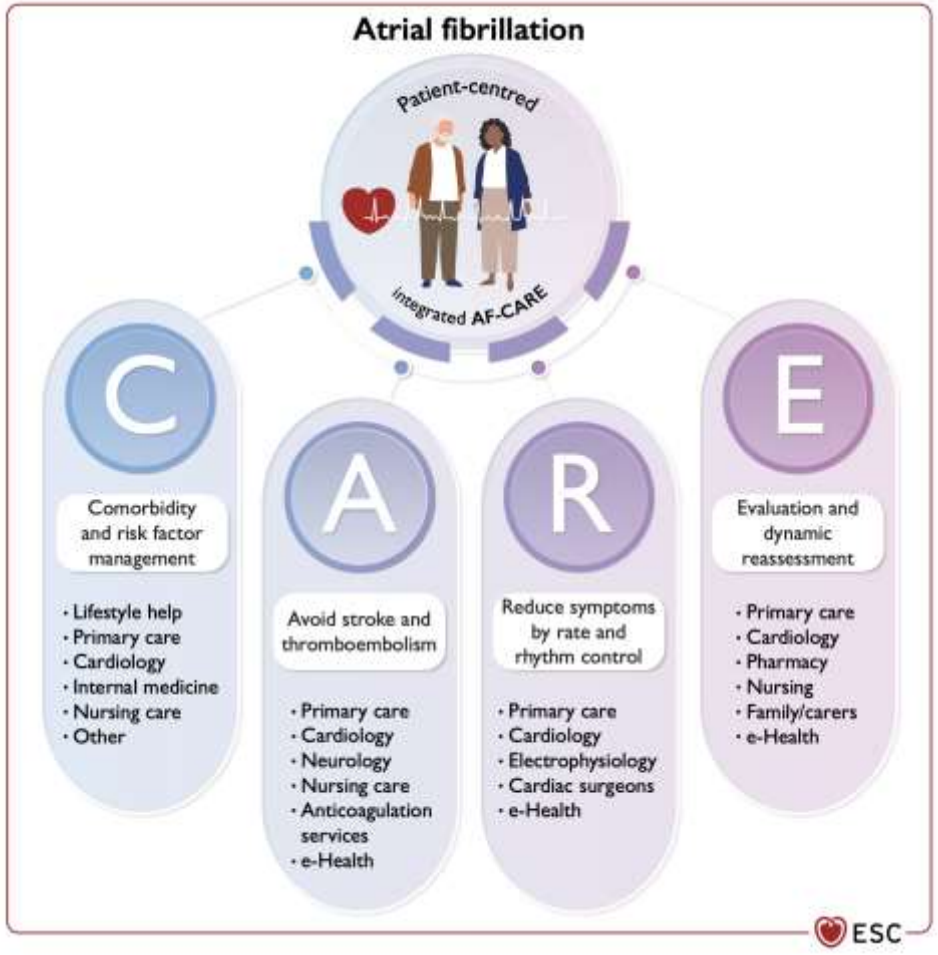


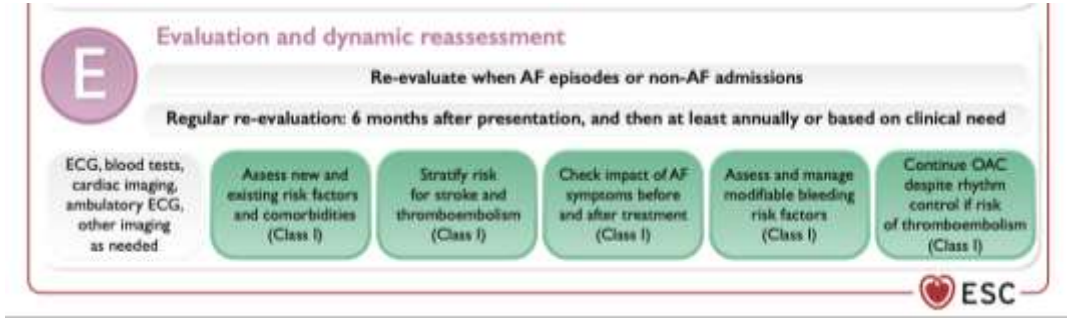
	Full MANIFEST-17K cohort (*N*=17,642)
Demographic	
Age (years), mean (minimum–maximum)	64 (11–96)
Female (%)	34.7
Indication for ablation	
Paroxysmal atrial fibrillation (%)	57.8
Persistent atrial fibrillation (%)	35.2
Long-standing persistent atrial fibrillation (%)	5.6
Atrial flutter/atrial tachycardia (%)	1.4
Sedation	
General anesthesia (%)	46.9
Deep sedation/no intubation (%)	53.1



Ekanem E, et al. Nat Med 2024;30:2020-9

Patient-centered multidisciplinary pathway





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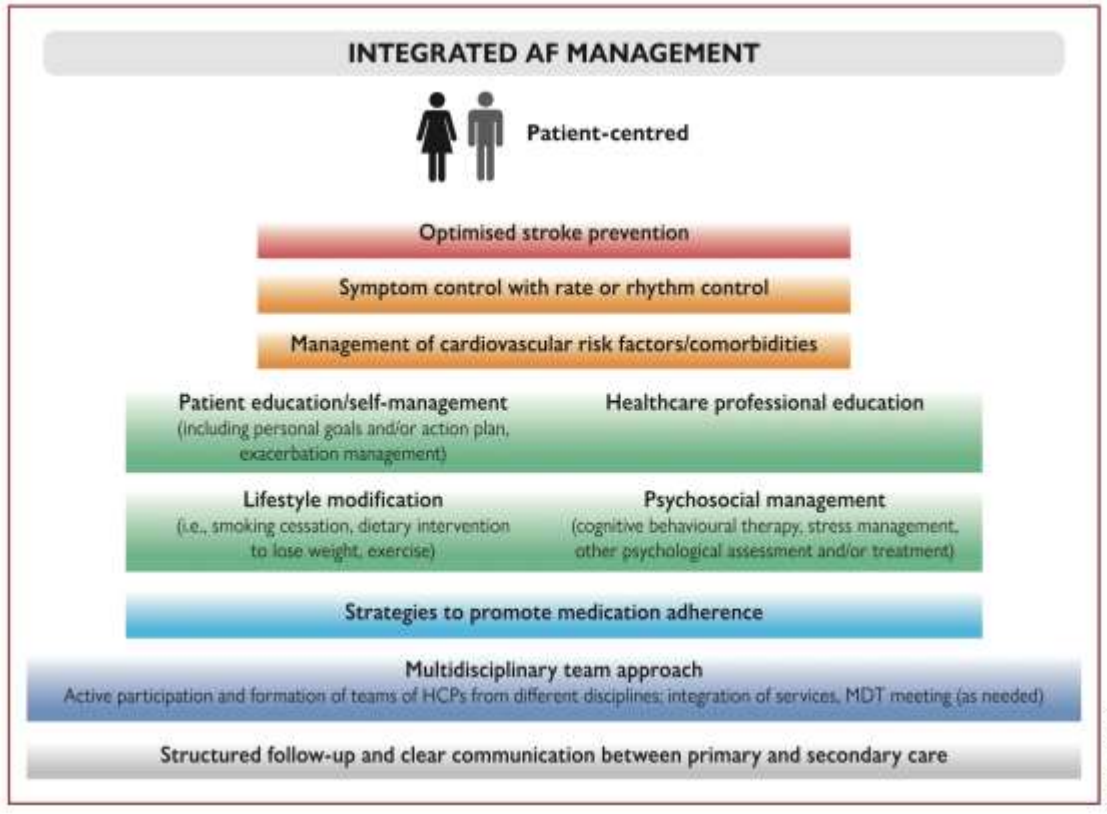
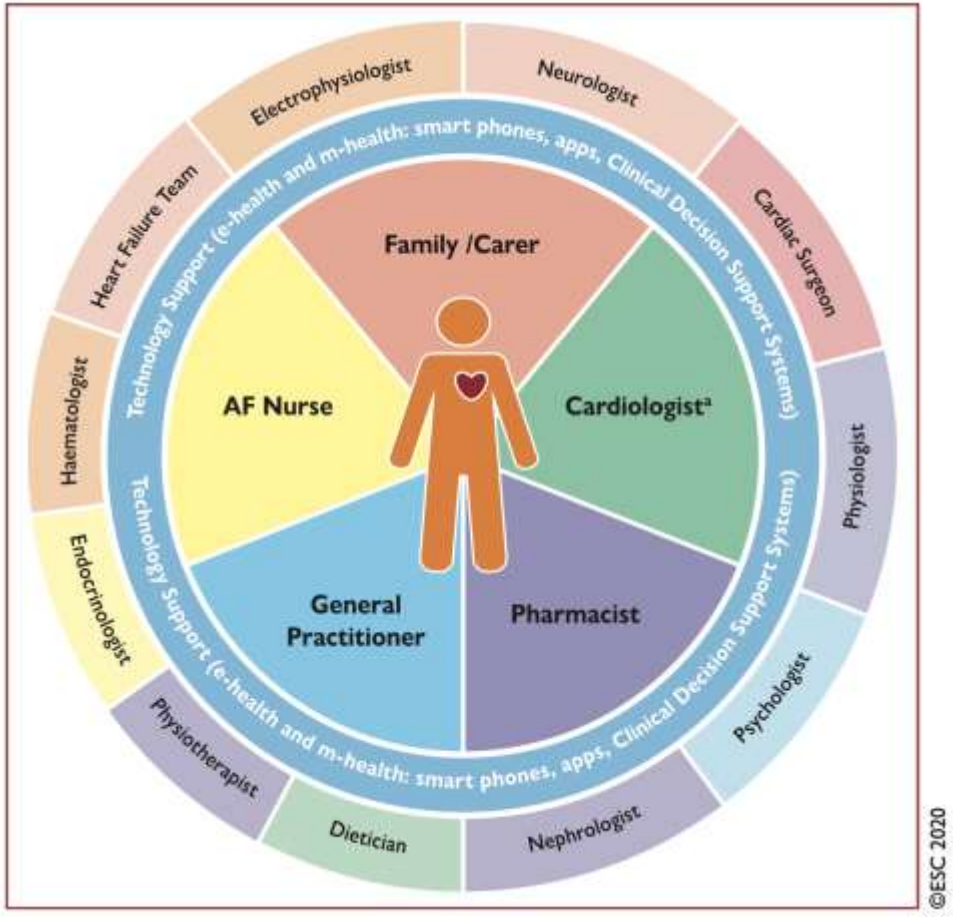
Patient-centered multidisciplinary pathway





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Atrial Fibrillation