고신대학교복음병원
KOSIN UNIVERSITY GOSPEL HOSPITAL

Current Guidelines for the Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death

Sung Il Im
Kosin University Gospel Hospital
Kosin University College of Medicine

The Korean Heart Rhythm Society
COI Disclosure

Name of First Author: Sung Il Im

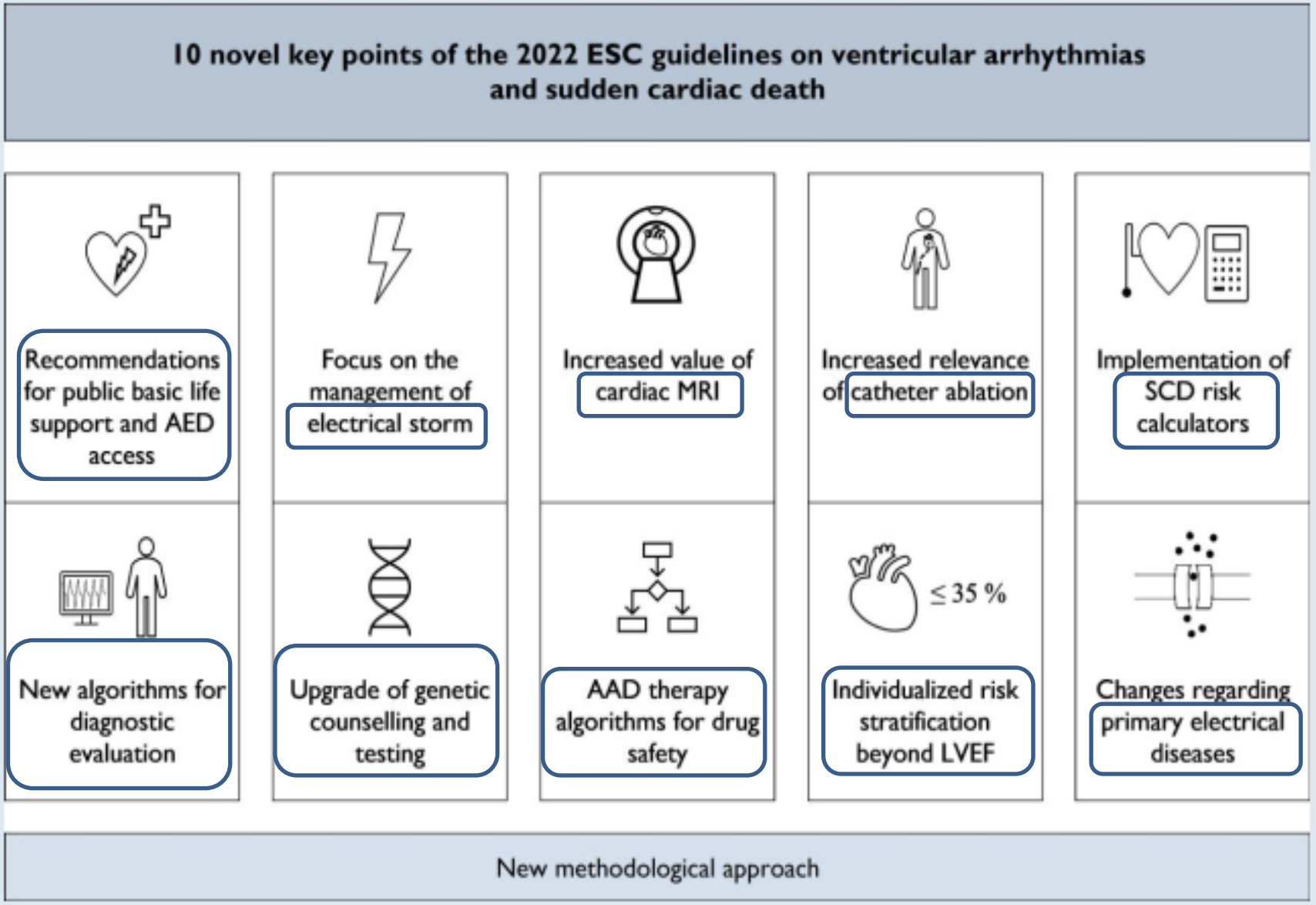
The authors have no financial conflicts of interest to disclose concerning the presentation

Introduction

- **Sudden cardiac death and ventricular arrhythmias are a global health issue** (responsible for approximately 10–20% of all deaths).

- Recently, **new 2022 guideline** for the management of ventricular arrhythmias and prevention of sudden cardiac death has been published by the **European Society of Cardiology that serves as an update to the 2015 guideline on this topic**.

- On more than **130 pages, the new guideline contains more than hundred new recommendations** and various new chapters and sections.



Overview on 10 novel key points of the 2022 ESC guideline on ventricular arrhythmias and sudden cardiac death compared to the 2015 ESC guideline. AAD, antiarrhythmic drug use; AED, automated external defibrillator; MRI, magnetic resonance imaging; LVEF, left ventricular ejection fraction; SCD, sudden cardiac death.

Public basic life support and access to automatic external defibrillators

Table 4 New recommendations in 2022

Recommendations	Class
Public basic life support and access to AEDs	
It is recommended that public-access defibrillation be available at sites where cardiac arrest is more likely to occur.[a]	I
Prompt CPR by bystanders is recommended at OHCA.	I
It is recommended to promote community training in basic life support to increase bystander CPR rate and AED use.	I
Mobile phone-based alerting of basic life support-trained bystander volunteers to assist nearby OHCA victims should be considered.	IIa

Table 4 **New recommendations in 2022**

Recommendations	Class
Treatment of VA. General aspects	
DC cardioversion is recommended as the first-line treatment for patients presenting with tolerated SMVT provided that the anaesthetic/sedation risk is low.	I
Optimal medical treatment including ACE-I/ARB/ARNIs, MRAs, beta-blockers, and SGLT2 inhibitors is indicated in all heart failure patients with reduced EF.	I
Implantation of a cardioverter defibrillator is only recommended in patients who have an expectation of good-quality survival >1 year.	I
Coronary artery disease	
In patients with CAD and recurrent, symptomatic SMVT, or ICD shocks for SMVT despite chronic amiodarone therapy, catheter ablation is recommended in preference to escalating AAD therapy.	I
Cardiac stress imaging during physical exercise is recommended in addition to cardiopulmonary exercise test after surgery in patients with anomalous aortic origin of a coronary artery with a history of aborted CA.	I

Table 4 New recommendations in 2022

Recommendations	Class
Idiopathic PVC/VT and PVC-induced cardiomyopathy	
Catheter ablation as first-line treatment is recommended for symptomatic idiopathic VT/PVCs from the RVOT or the left fascicles.	I
Beta-blockers or non-dihydropyridine CCBs are indicated in symptomatic patients with idiopathic VT/PVCs from an origin other than the RVOT or the left fascicles.	I
Amiodarone as a first-line treatment is not recommended in patients with idiopathic VTs/PVCs.	III
DCM/HNDCM	
Genetic testing (including at least *LMNA*, *PLN*, *RBM20*, and *FLNC* genes) is recommended in patients with DCM/HNDCM and AV conduction delay at <50 years, or who have a family history of DCM/HNDCM or SCD in a first-degree relative (at age <50 years).	I
In a first-degree relative of a DCM/HNDCM patient, an ECG, and an echocardiogram are recommended if: • the index patient was diagnosed <50 years of age or has clinical features suggestive of an inherited cause, or • there is a family history of DCM/HNDCM, or premature unexpected SD.	I

Table 4 **New recommendations in 2022**

Recommendations	Class
DCM/HNDCM	
Participation in high-intensity exercise including competitive sports is not recommended for individuals with DCM/HNDCM and a *LMNA* mutation.	III

Table 4 **New recommendations in 2022**

Recommendations	Class
ARVC	
In patients with suspected ARVC, CMR is recommended.	I
In patients with a suspected or definite diagnosis of ARVC, genetic counselling and testing are recommended.	I
HCM	
CMR with LGE is recommended in HCM patients for diagnostic work-up.	I
Genetic counselling and testing are recommended in HCM patients.	I
In a first-degree relative of a patient with HCM, ECG, and echocardiogram are recommended.	I

Table 4 **New recommendations in 2022**

Recommendations	Class
Neuromuscular diseases	
Invasive electrophysiological evaluation is recommended in patients with myotonic dystrophy and palpitations or syncope suggestive of VA or surviving a CA.	I
ICD implantation is recommended in patients with myotonic dystrophy and SMVT or aborted CA not caused by BBR-VT.	I
In patients with myotonic dystrophy, serial electrophysiological evaluation of AV conduction and arrhythmia induction is not recommended without arrhythmia suspicion or progression of ECG conduction disorders.	III
Congenital heart disease	
In patients with CHD presenting with sustained VAs, evaluation for residual lesions or new structural abnormalities is recommended.	I

Table 4 **New recommendations in 2022**

Recommendations	Class
Idiopathic VF	
It is recommended that idiopathic VF is diagnosed in a SCA survivor, preferably with documentation of VF, after exclusion of an underlying structural, channelopathic, metabolic, or toxicological aetiology.	I
Long QT syndrome	
In patients with clinically diagnosed LQTS, genetic testing, and genetic counselling are recommended.	I
Beta-blockers, ideally non-selective beta-blockers (nadolol or propranolol), are recommended in LQTS patients with documented QT interval prolongation, to reduce risk of arrhythmic events.	I
Mexiletine is indicated in LQT3 patients with a prolonged QT interval.	I
Routine diagnostic testing with epinephrine challenge is not recommended in LQTS.	III

Table 4 New recommendations in 2022

Recommendations	Class
Andersen–Tawil syndrome	
Genetic testing is recommended in patients with suspected Andersen–Tawil syndrome.	I
ICD implantation is recommended in patients with Andersen–Tawil syndrome after aborted CA or not-tolerated sustained VT.	I
Brugada syndrome	
Genetic testing for *SCN5A* gene is recommended for probands with BrS.	I
Sodium channel blocker test is not recommended in patients with a prior type I Brugada pattern.	III
Catheter ablation in asymptomatic BrS patients is not recommended.	III

Table 4 New recommendations in 2022

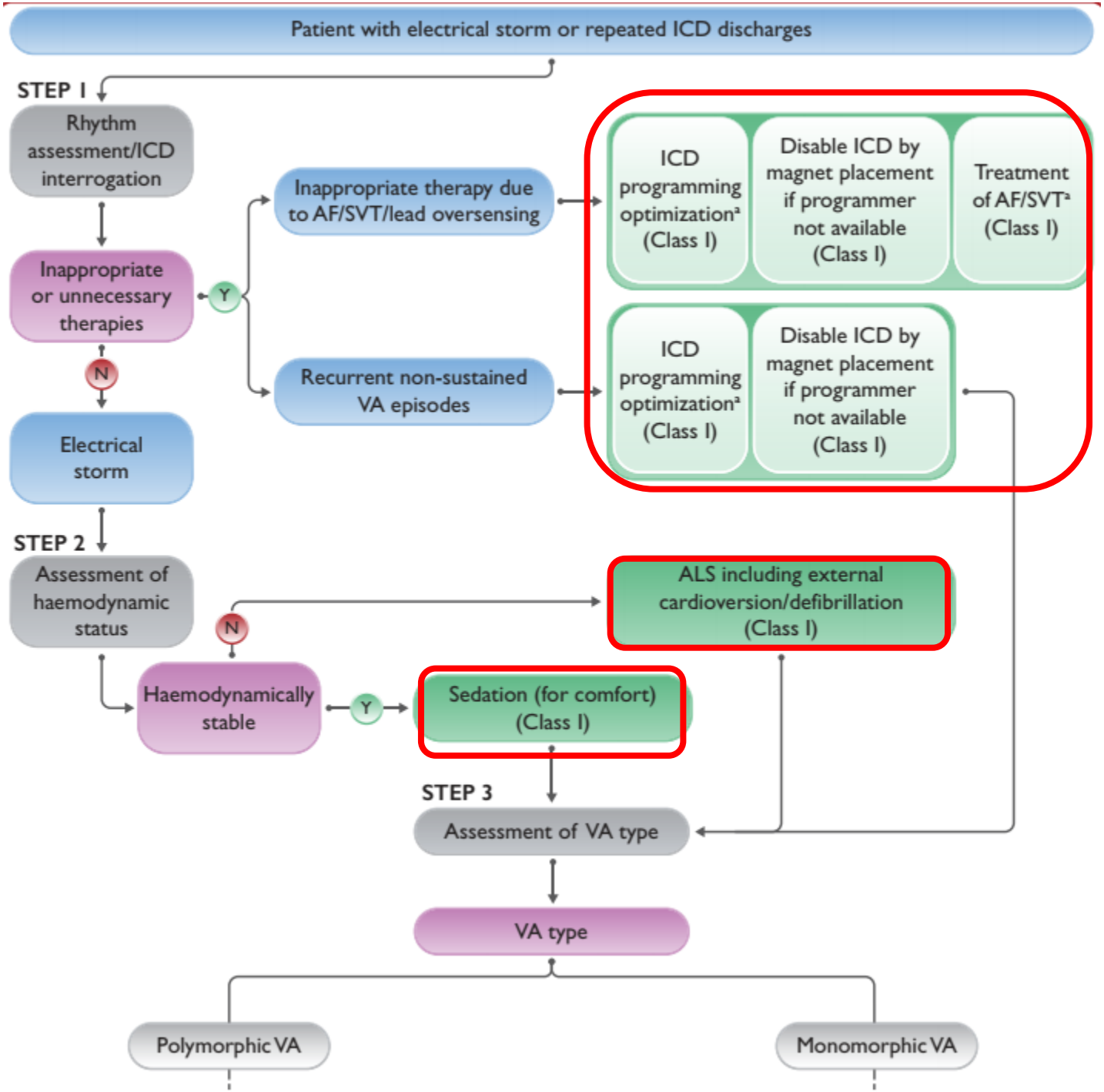
Recommendations	Class
Early repolarization syndrome	
It is recommended that the ERP is diagnosed as J-point elevation of >1 mm in two adjacent inferior and/or lateral ECG leads.	I
It is recommended that the ERS is diagnosed in a patient resuscitated from unexplained VF/PVT in the presence of ERP.	I
ICD implantation is recommended in patients with a diagnosis of ERS who have survived a CA.	I
Clinical evaluation is not recommended routinely in asymptomatic subjects with ERP.	III
ICD implantation is not recommended in asymptomatic patients with an isolated ERP.	III

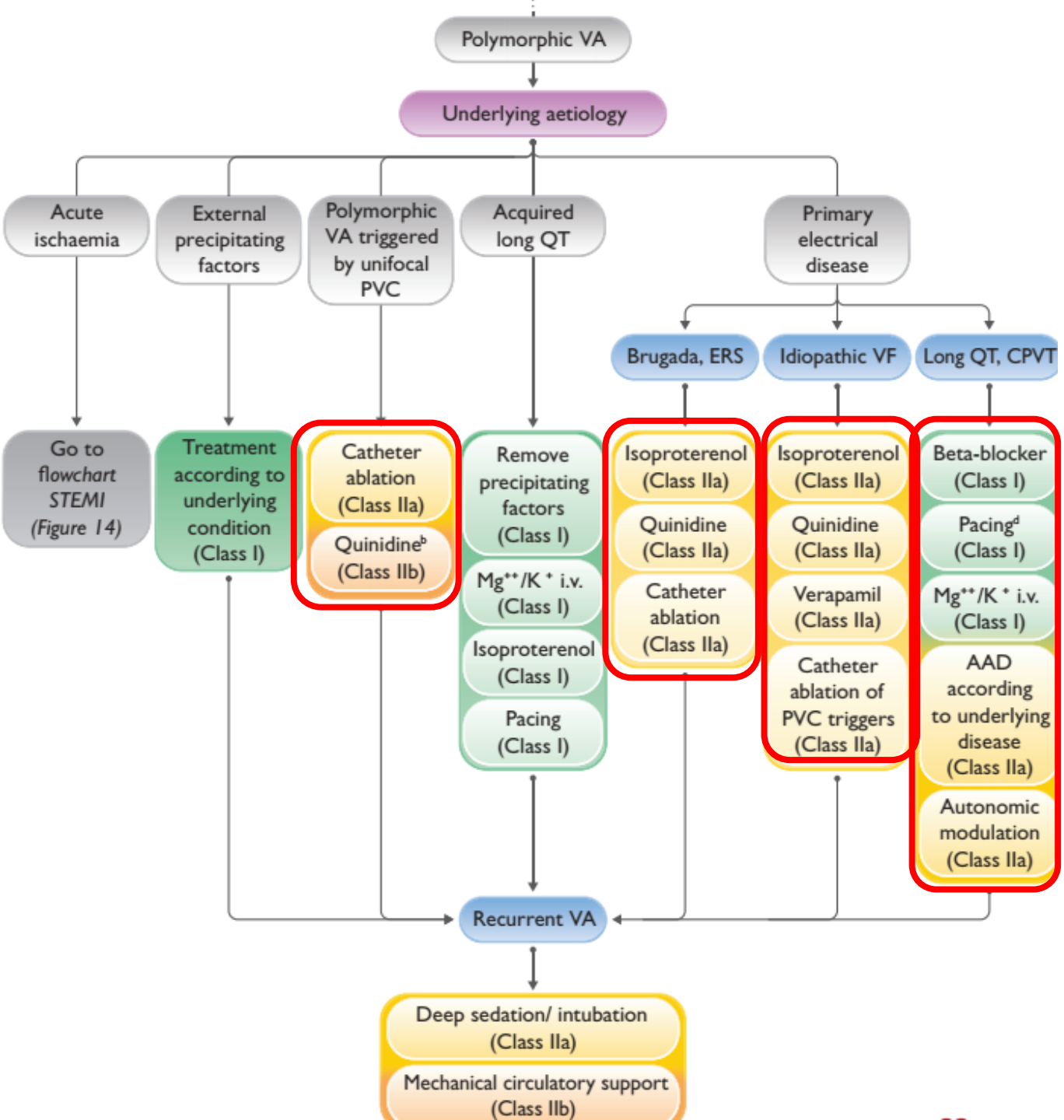
Table 4 **New recommendations in 2022**

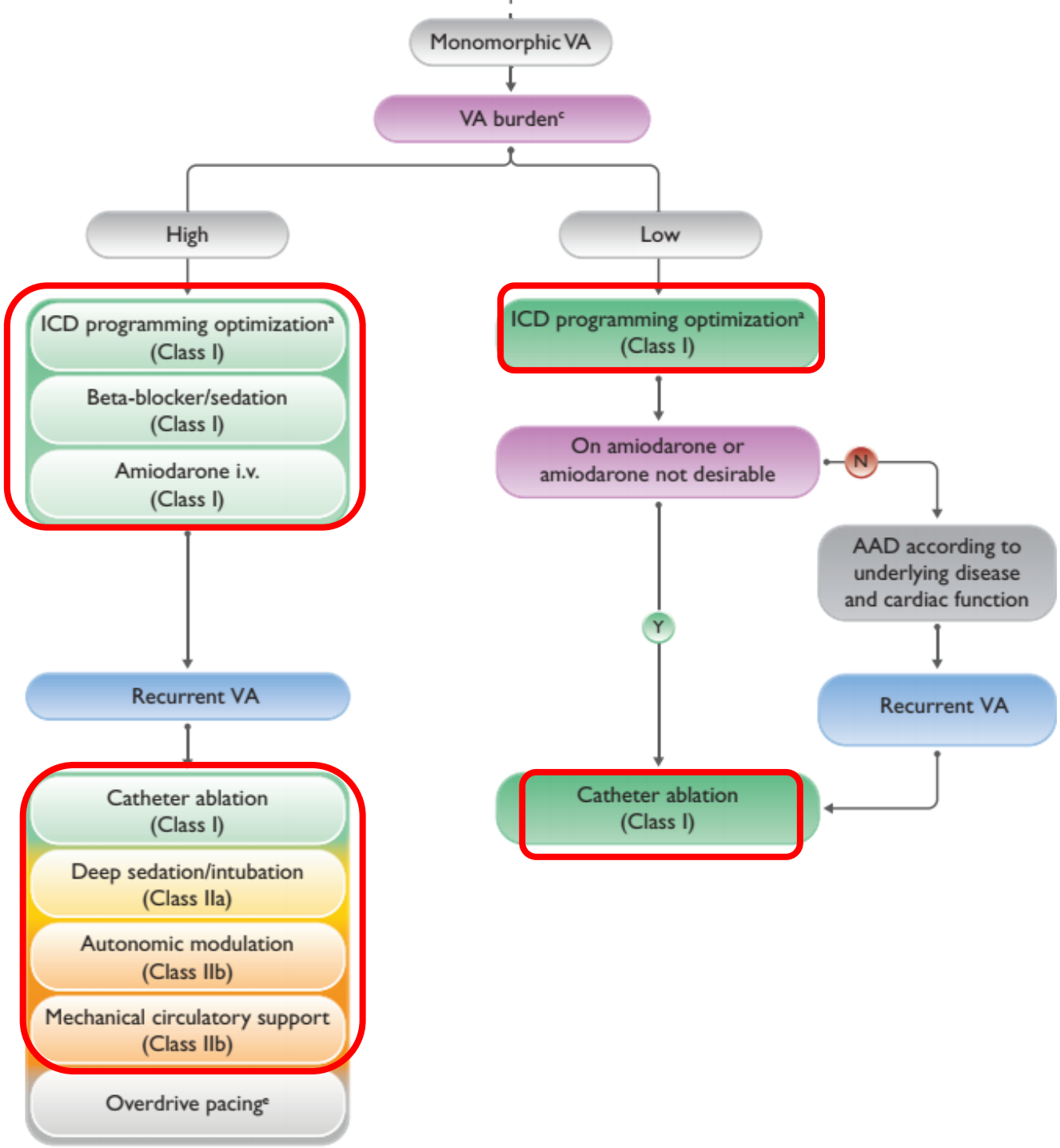
Recommendations	Class
CPVT	
Genetic testing and genetic counselling are indicated in patients with clinical suspicion or clinical diagnosis of CPVT.	I
Beta-blockers, ideally non-selective (nadolol or propranolol) are recommended in all patients with a clinical diagnosis of CPVT.	I
Short QT syndrome	
Genetic testing is indicated in patients diagnosed with SQTS.	I
Selected populations	
It is recommended that athletes diagnosed with a cardiovascular disease associated with SCD are managed according to current guidelines for sports eligibility.	I

New focus on managing electrical storm

- For the first time, **new guideline devotes a separate chapter** to the **management of patients with electrical storm**, which is **defined as three or more separate sustained VA within 24 h each requiring termination** by an intervention.


Patient with electrical storm or repeated ICD discharges
STEP 1
Rhythm assessment/ICD interrogation
Inappropriate or unnecessary therapies
Y
N
Inappropriate therapy due to AF/SVT/lead oversensing
Recurrent non-sustained VA episodes
ICD programming optimization² (Class I)
Disable ICD by magnet placement if programmer not available (Class I)
Treatment of AF/SVT² (Class I)
ICD programming optimization² (Class I)
Disable ICD by magnet placement if programmer not available (Class I)
Electrical storm
STEP 2
Assessment of haemodynamic status
N
ALS including external cardioversion/defibrillation (Class I)
Haemodynamically stable
Y
Sedation (for comfort) (Class I)
STEP 3
Assessment of VA type
VA type
Polymorphic VA
Monomorphic VA


Polymorphic VA
Underlying aetiology
Acute ischaemia
External precipitating factors
Polymorphic VA triggered by unifocal PVC
Acquired long QT
Primary electrical disease
Brugada, ERS
Idiopathic VF
Long QT, CPVT
Go to flowchart STEMI (Figure 14)
Treatment according to underlying condition (Class I)
Catheter ablation (Class IIa)
Quinidine[b] (Class IIb)
Remove precipitating factors (Class I)
Mg++/K+ i.v. (Class I)
Isoproterenol (Class I)
Pacing (Class I)
Isoproterenol (Class IIa)
Quinidine (Class IIa)
Catheter ablation (Class IIa)
Isoproterenol (Class IIa)
Quinidine (Class IIa)
Verapamil (Class IIa)
Catheter ablation of PVC triggers (Class IIa)
Beta-blocker (Class I)
Pacing[d] (Class I)
Mg++/K+ i.v. (Class I)
AAD according to underlying disease (Class IIa)
Autonomic modulation (Class IIa)
Recurrent VA
Deep sedation/ intubation (Class IIa)
Mechanical circulatory support (Class IIb)


Monomorphic VA
VA burden[c]
High
Low
ICD programming optimization[a] (Class I)
Beta-blocker/sedation (Class I)
Amiodarone i.v. (Class I)
ICD programming optimization[a] (Class I)
On amiodarone or amiodarone not desirable
N
AAD according to underlying disease and cardiac function
Y
Recurrent VA
Recurrent VA
Catheter ablation (Class I)
Deep sedation/intubation (Class IIa)
Autonomic modulation (Class IIb)
Mechanical circulatory support (Class IIb)
Overdrive pacing[e]
Catheter ablation (Class I)

Genetic counselling and testing

- **The value of genetic counselling and testing as part of the diagnostic evaluation and for risk stratification** of patients with VA has **significantly increased** from the 2015 to the current ESC guideline.

Table 1 Comparison of specific recommendations for genetic testing and counselling

General recommendations	Level of recommendation	
	2015 ESC guideline	2022 ESC guideline
Post-mortem genetic testing for additional genes in the decedent following SADS	—	IIb
Hypothesis-free post-mortem genetic testing following SADS	—	III
Patients with apparently sporadic DCM/HNDCM, who present at young age or with signs suspicious for an inherited aetiology	—	IIa
Patients with idiopathic VF	—	IIb
Patients with early repolarization syndrome	—	IIb

Increasing relevance of cardiac magnetic resonance imaging

- The value of **cardiac magnetic resonance imaging (CMR)** for **diagnostic evaluation and especially for risk stratification** and its role in the **decision-making on primary preventive ICD therapy** have been significantly **upgraded with the latest guideline**.

Table 2 Comparison of specific recommendations for the use of cardiac MRI

General recommendations for cardiac MRI	Level of recommendation	
	2015 ESC guideline	2022 ESC guideline
Survivors of sudden cardiac arrest without a clear underlying cause	—	I
Patients with newly documented VA and suspicion of a structural heart disease other than coronary artery disease after initial evaluation	—	IIa
Patients with VA when echocardiography does not provide accurate assessment of ventricular function and/or evaluation of structural changes	IIa	—
Relatives of sudden arrhythmic death syndrome-decedents	—	IIb
Cardiac MRI in the context of idiopathic PVC/VT and PVC-induced cardiomyopathy		
Patients with PVCs/VT and a presentation not typical for an idiopathic origin, despite a normal echocardiogram	—	IIa
Patients with suspected PVC-induced cardiomyopathy	—	IIa
Cardiac MRI in the context of structural heart disease		
Patients with suspected ARVC	—	I
Patients with HCM	—	I
Patients with DCM/HNDCM	—	IIa
Cardiac MRI in selected populations		
Athletes with a positive medical history, abnormal physical examination, or ECG alterations	I	I

Increasing value of catheter ablation in the management of VA

- The **recommendations of the new ESC guideline** reflect an increasing **relevance of catheter ablation** in the **acute and long-term management of VA in patients with and without SHD**

Table 3 Comparison of specific recommendations for catheter ablation in acute and long-term management of ventricular arrhythmias

Specific recommendations for catheter ablation in the acute treatment of ventricular arrhythmias	Level of recommendation	
	2015 ESC guideline	2022 ESC guideline
Incessant VT or electrical storm due to SMVT refractory to AAD	I	I
Recurrent episodes of PVT/VF triggered by a similar PVC, non-responsive to medical treatment or coronary revascularization	IIa	IIa
Recurrent episodes of PVT/VF triggered by a similar PVC non-responsive to medical treatment or coronary revascularization in the subacute phase of myocardial infarction	—	IIa

Recommendations on catheter ablation for the long-term management of ventricular arrhythmias	Level of recommendation	
	2015 ESC guideline	2022 ESC guideline
General recommendations		
Catheter ablation (or amiodarone) in patients with recurrent ICD shocks due to sustained VT	I	—
Patients with SMVT or SPVT/VF triggered by a PVC with similar morphology and an indication for ICD when an ICD is not available, contraindicated for concurrent medical reasons, or declined	—	IIb
Chronic coronary artery disease		
Recurrent symptomatic SMVT, or ICD shocks for SMVT despite chronic amiodarone therapy, in preference to escalating AAD therapy	—	I
Recurrent ICD shocks due to sustained VT	I	—
After a first episode of sustained VT in patients with an ICD	IIa	—
Recurrent symptomatic SMVT, or ICD shocks for SMVT despite betablockers or sotalol treatment	—	IIa
Haemodynamically well-tolerated SMVT and LVEF > 40%, as an alternative to ICD therapy	—	IIa
Catheter ablation just before (or immediately after) ICD implantation to decrease subsequent VT burden and ICD shocks	—	IIb

Recommendations on catheter ablation for the long-term management of ventricular arrhythmias	Level of recommendation	
	2015 ESC guideline	2022 ESC guideline
Dilated cardiomyopathy/Hypokinetic non-dilated cardiomyopathy		
Bundle branch re-entrant tachycardia refractory to medical therapy	I	—
Recurrent, symptomatic SMVT or ICD shocks for SMVT, in whom AAD are ineffective, contraindicated, or not tolerated	IIb	IIa
Hypertrophic cardiomyopathy		
Selected patients with HCM and recurrent, symptomatic SMVT or ICD shocks for SMVT, in whom AADs are ineffective, contraindicated, or not tolerated	—	IIb
Arrhythmogenic right ventricular cardiomyopathy		
Recurrent, symptomatic SMVT or ICD shocks for SMVT despite beta-blockers (2015: frequent symptomatic PVC included)	IIa	IIa
Congenital heart disease		
Recurrent, symptomatic SMVT or ICD shocks for SMVT not manageable by medical therapy or ICD reprogramming	I	IIa
Patients with repaired TOF with SMVT or recurrent, symptomatic appropriate ICD therapy for SMVT	—	I
CHD patients with an ICD and symptomatic SMVT, as an alternative to drug therapy	IIa	—
Patients with repaired TOF with a preserved biventricular function and symptomatic SMVT, as an alternative to ICD therapy	—	IIb
Valvular heart disease		
Programmed electrical stimulation with standby catheter ablation in patients with aortic valve disease and SMVT to identify and ablate bundle re-entrant ventricular tachycardia, especially if it occurs following a valve intervention	IIa	I

Recommendations on catheter ablation for the long-term management of ventricular arrhythmias	Level of recommendation	
	2015 ESC guideline	2022 ESC guideline
Idiopathic ventricular fibrillation		
Recurrent episodes of VF triggered by a similar PVC non-responsive to medical treatment	I	IIa
Brugada Syndrome		
Catheter ablation of triggering PVCs and/or RVOT substrate in patients with recurrent appropriate ICD shocks refractory to drug therapy	IIb	IIa
Short-coupled torsade de pointes		
Catheter ablation for long-term suppression/prevention of electrical storm or recurrent ICD discharges	IIa	—
Neuromuscular diseases		
Symptomatic patients with bundle re-entrant ventricular tachycardia	I	I
Inflammatory diseases		
Post-myocarditis patients with recurrent, symptomatic SMVT or ICD shocks for SMVT, in whom AADs are ineffective, contraindicated, or not tolerated	—	IIa
Patients with haemodynamically well-tolerated SMVT occurring in the chronic phase of myocarditis with preserved LV function and a limited scar amenable to ablation, as an alternative to ICD therapy	—	IIb
Cardiac sarcoidosis ICD-recipients with recurrent, symptomatic SMVT or ICD shocks for SMVT, in whom AADs are ineffective, contraindicated, or not tolerated	—	IIb

Recommendations on catheter ablation for the long-term management of ventricular arrhythmias	Level of recommendation	
	2015 ESC guideline	2022 ESC guideline
Idiopathic PVCs/VT		
First-line treatment for symptomatic idiopathic VT/PVCs from the RVOT	—	I
First-line treatment for symptomatic idiopathic VT/PVCs from the left fascicles	I	I
Symptomatic patients with idiopathic VT/PVC from the RVOT and/or failure of AAD therapy or decline in LV function due to RVOT-PVC burden	I	—
Catheter ablation for symptomatic idiopathic VT/PVCs from an origin other than the RVOT or the left fascicles	—	IIa
Catheter ablation of LVOT/aortic cusp/epicardial VT/PVC after failure of one or more sodium channel blockers or in patients not wanting long-term AAD therapy	IIa	—
Symptomatic patients with papillary muscle tachycardia, mitral and tricuspid annular tachycardia after failure of one or more sodium channel blockers or in patients refusing long-term AAD therapy	IIa	—
Asymptomatic patients with > 20% of idiopathic PVCs per day repeatedly at follow-up		IIb
PVC-induced or PVC-aggravated cardiomyopathy		
Cardiomyopathy suspected to be caused by frequent and predominately monomorphic PVCs	IIa	I
SHD patients in whom predominately monomorphic frequent PVCs are suspected to be contributing to the cardiomyopathy	IIa	IIa
Non-responders to CRT with frequent, predominately monomorphic PVCs limiting optimal biventricular pacing despite pharmacological therapy	—	IIa

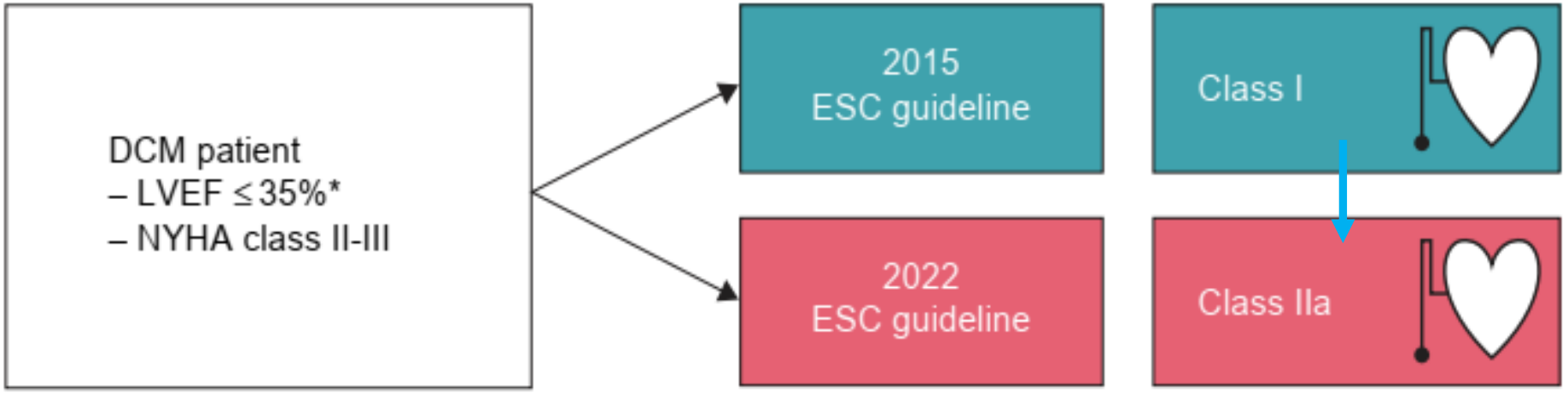
Table 9 Summary of the recommendations for the treatment of patients with frequent idiopathic premature ventricular complexes/ventricular tachycardia or premature ventricular complex-induced cardiomyopathy

	Ablation	Beta-blocker	CCB	Flecainide	Amiodarone
RVOT/fascicular PVC/VT: Symptomatic, normal LV function	Class I	Class IIa	Class IIa	Class IIa	Class III
PVC/VT other than RVOT/fascicular: Symptomatic, normal LV function	Class IIa	Class I	Class I	Class IIa	Class III
RVOT/fascicular PVC/VT: LV dysfunction	Class I	Class IIa	Class III[a]	Class IIa[b]	Class IIa
PVC/VT other than RVOT/fascicular: LV dysfunction	Class I	Class IIa	Class III[a]	Class IIa[b]	Class IIa
PVC: Burden >20%, asymptomatic, normal LV function	Class IIb				Class III

Changes in SCD risk stratification

- As identifying individuals **at highest risk of SCD for successful primary preventive ICD therapy is challenging**, **criteria for primary preventive ICD therapy are among the most controversial and extensively discussed** topics in both the **2015 and 2022 guidelines.**

ICD implantation for dilated cardiomyopathy

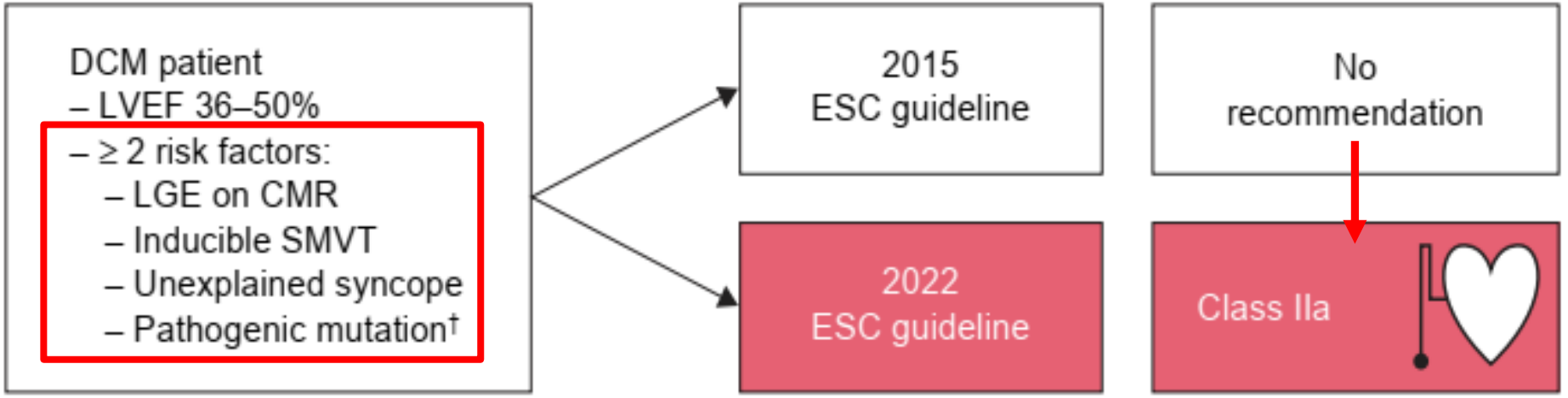


*After optimal medical heart failure treatment for ≥ 3 months

- New guidelines, mainly **based on results of the DANISH trial** downgraded that recommendation to a **class IIa recommendation** for ICD implantation.

- In this patient group, **clinical parameters might be considered** but are **not part of the recommended risk stratification** as **data are limited!!!**
  :including personal history regarding unexplained syncope, comorbidities, life expectancy, biomarkers (NT-proBNP) and echo parameters as the global longitudinal strain]

ICD implantation for dilated cardiomyopathy



- Beyond LVEF and NYHA class, **New guideline incorporates alternative risk** markers such as **unexplained syncope** and **inducibility of SMVT** in addition to criteria such as **LGE on MRI** and **certain genetic mutations** in PLN, FLNC, and RBM20 genes.

→ New recommendation for ICD implantation in DCM patients with LVEF (35~50%) and **≥ 2** of these risk factors has been introduced.

- Yet, **prospective data on this issue are lacking!!!.**

Changes in primary electrical diseases

- New in the 2022 guidelines are **specific criteria for an early repolarization pattern and the early repolarization syndrome**.

  : ERP can be a benign finding and is distinct from ERS.

- Whereas the 2015 guideline allowed the diagnosis of BrS in patients with an **induced type 1 Brugada ECG**,

→ New guideline **additionally demands clinical factors**

: survived cardiac arrest (class I), positive family history, arrhythmic syncope for the diagnosis of BrS.

- Similarly, **diagnostic criteria for SQTS** have changed, including specific pathogenic mutations, a family history of SQTS or of survived SCD due to VT/VF, are required in addition to a **short QTc interval ≤ 360 ms**.

Changes in primary electrical diseases

- **In CPVT, flecainide should be considered in addition to beta-blocker therapy** in symptomatic patients with **polymorphic or bidirectional VT**, **persistent exertional PVCs, or recurrent syncope** irrespective of a proven presence of a disease specific mutation.

- **Recommendations for left cardiac sympathetic denervation are upgraded** not only in the context of LQTS but also in CPVT.

- **Implantable loop recorders may assist risk stratification** in young SQTS patients and patients with an ERP and additional risk features.

Thank You for Your Attention!!