Current perspectives

Risk stratification for arrhythmic events in patients with idiopathic dilated cardiomyopathy: a review of the literature and current perspectives

Leonardo Calò, Petr Peichl, Alan Bulava, Filippo Lamberti, Maria Luisa Loricchio, Antonio Castro, Antonella Meo, Claudio Pandozi, Massimo Santini

Department of Cardiac Diseases, San Filippo Neri Hospital, Rome, Italy

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The prognosis for patients with idiopathic dilated cardiomyopathy (DCM) has markedly improved during the last decade, mainly because of advancements in therapeutic strategies. However, sudden death still accounts for a significant part of the total mortality in patients with moderate disease. Recent primary prophylactic trials failed to demonstrate any benefit of cardioverter-defibrillator implantation in an unselected group of idiopathic DCM patients and thus the identification of the subgroup of patients at high arrhythmic risk is crucial. Although different risk stratification methods have been evaluated in risk assessment, the reported clinical value differs in studies, mainly because of differences in either methodology and/or patient selection. The present review focuses on arrhythmic events in idiopathic DCM and on the value of noninvasive methods and electrophysiological study in the risk stratification of this group of patients.

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Address:
Dr. Leonardo Calò
Via della Pedica, 348
00046 Grottaferrata (RM)
E-mail:
leonardo.calo@tin.it

Introduction

Dilated cardiomyopathy (DCM) is a syndrome characterized by left or biventricular dilation and impaired systolic function. Various etiologies can lead to DCM: coronary artery disease (CAD), valvular heart disease, alcohol abuse, hypertension, pregnancy, and infections. On the other hand, idiopathic DCM is rare (its prevalence is approximately 38/100 000)[1] and is defined by its not determined etiology, although autoimmune, genetic, viral and metabolic causes have been proposed. The multiple and overlapping underlying etiologies of DCM lead to patient population heterogeneity and to difficulties in studying the disease, but despite this fact the common feature of DCM patients remains the high incidence of sudden cardiac death (SCD). This review focuses on arrhythmias present in patients with idiopathic DCM and on the current possibilities of risk stratification of such patients either with noninvasive or invasive techniques.

Incidence

The prognosis of idiopathic DCM has undergone striking changes. According to studies published in the '80s, annual mortality rates up to 25-30% have been reported, reaching 70% after 5 years of follow-up[2]. More recent observations suggest improved survival with total mortality reaching only 7-12% and 20% after 2 and 4 years respectively[3,4]. These changes reflect advancements in the treatment of congestive heart failure (CHF), consisting mainly of the use of angiotensin-converting enzyme (ACE)-inhibitors and beta-blockers. However, SCD still accounts for 30-50% of the overall mortality[5-7].

Arrhythmogenesis

In comparison to CAD, where the majority of ventricular arrhythmias are scar-related, autopsy series have demonstrated visually evident left ventricular scars only in 14 of 152 patients with nonischemic DCM[8]. Similarly, Pogwizd et al.[9] described a focal origin of spontaneous nonsustained ventricular tachycardias (NSVT) consequent to either early or delayed afterdepolarizations. Thus, various mechanisms of arrhythmogenesis have to be considered. Arrhythmias in heart failure arise from a

complex interplay between the substrate and facilitating and triggering factors. Cellular hypertrophy and interstitial fibrosis in the failing heart cause prolongation of the action potential. An alternation of K^+ currents creates spatial heterogeneity of repolarization as occurs in the long QT syndromes[10]. Intracellular calcium overload may be linked to early afterdepolarizations and trigger torsades de pointes. Myocardial stretch due to mechanical overloading can increase refractoriness and membrane potential imbalance which result in early afterdepolarizations, increased automaticity, and ectopic beats[11]. Electrolyte imbalances, especially hypokalemia and hypomagnesemia caused by diuretic therapy, activation of the sympathetic nervous system and increased circulating catecholamines also precipitate arrhythmias.

Type of arrhythmic events

Ventricular tachycardias (VTs), most often polymorphic, rapidly degenerating into ventricular fibrillation (VF), are the most likely cause of SCD due to tachyarrhythmias. Nevertheless, the difficulty of classifying deaths as sudden and nonsudden, and as tachyarrhythmic, bradyarrhythmic or noncardiac should be borne in mind. Pratt et al.[12] have analyzed deaths in 109 patients who received an implantable cardioverter-defibrillator (ICD). Seventeen were classified as SCD, but the autopsy information contradicted and changed the clinical perception of a SCD in 7 cases. ICD interrogation revealed that the ICD discharges were often related to terminal arrhythmias incidental to the primary pathophysiological process leading to death. They concluded that even in ICD patients, death classified as SCD was frequently not associated with VT or VF and was often noncardiac. According to one study of nonischemic DCM patients with VTs undergoing radiofrequency catheter ablation, 58% of presenting VTs were due to scar-related reentry, 27% due to focal automaticity, and 19% were bundle branch or fascicular reentry[13]. However, this cohort only refers to recurrent tachycardias inducible during electrophysiological study (EPS) and the real spectrum may be different. In studies including patients with idiopathic DCM and syncope after ICD implantation, the majority of arrhythmic events were rapid monomorphic VTs[14,15]. Bayes de Luna et al.[16] have found that in 62% of patients VT that progressed to VF was observed before death. These data may indicate that the initial arrhythmia may have been VT, even though VF has been documented at the time of arrival of the emergency ambulance. Interestingly, monomorphic VT with a morphology of right bundle branch block and a superior axis predicts a high incidence of subsequent development of VT clusters requiring multiple ICD shocks while VTs of other morphologies induced during EPS do not[17] and the reason for this remains unclear.

Besides tachyarrhythmias, even bradycardia is an important cause of SCD in patients with idiopathic DCM. Luu et al.[18] reviewed 21 hospitalized monitored patients with end-stage CHF and showed that the rhythm recorded before cardiac arrest was bradycardia or electromechanical dissociation in 62% of all patients and in 100% of patients with idiopathic DCM. However, Faggiano et al.[19] did not find any significant difference between patients with ischemic and nonischemic cardiomyopathy, while the underlying rhythm during in-hospital cardiac arrest in this study was tachycardia in 58% and bradycardia in 42% of patients.

Nevertheless, bradyarrhythmia as a cause of SCD should not be overemphasized. It seems to be the cause of death in patients with end-stage CHF (NYHA class IV) submitted to intensive diuretic and inotropic drug therapy[19], while the majority of deaths in stable patients (NYHA class II or III) are attributable to VT or VF. Two observations support this hypothesis. First, pacemaker implantation in patients with conduction disorders and syncope has never been shown to reduce SCD or prolong survival[20] and second, there is a high incidence of appropriate ICD shocks due to ventricular tachyarrhythmias in patients with syncope and idiopathic DCM[14].

Risk stratification

Risk stratification for arrhythmic events in patients with idiopathic DCM is complex and probably related to the period of evaluation of these patients, being influenced by functional class, medical therapy, and left ventricular remodeling. Zecchin et al.[21] have observed that the risk of SCD increases during the first months following the initial evaluation with a *plateau* lasting about 3.5 years; then the risk rises progressively (mortality risk 3% at 3 months, 6% at 5 years, 18% at 10 years). This increased risk of SCD during follow-up is probably related to the clinical improvement and stabilization of patients with a decrease in pump failure death attributable to optimal medical therapy with ACE-inhibitors and beta-blockers. Therefore, the invasive and noninvasive tests in risk stratification should be considered for each patient in light of the time of observation (first observation?, long period of follow-up with optimal medical therapy and severe left ventricular dysfunction?).

Left ventricular ejection fraction, left ventricular diameters, NYHA functional class and atrial fibrillation. The left ventricular ejection fraction and functional class (NYHA) are the most powerful predictors of mortality[4-6,21-26]. Besides, the left ventricular diameters seem to be relevant in the risk stratification of SCD in idiopathic DCM[6,21,27]. Lee et al.[27] have demonstrated among patients with advanced heart failure that those with a left ventricular diameter > 4 cm/m^2 had a higher

risk of SCD (27 vs 14% after 1 year). Similarly, Zecchin et al.[21] have observed that SCD occurred, independently of symptoms, in patients with severe ventricular dilation and biventricular dysfunction. The association between a left ventricular ejection fraction < 30% and an end-diastolic diameter > 38 mm/m^2, at the time of evaluation, was correlated with a higher risk of sudden death during the following year (odds ratio 1.8, p = 0.005). These results suggest that ventricular dilation identifies a subgroup of patients at a higher risk of sudden death[21].

According to some studies[28,29] various factors such as conduction disorders, first- and second-degree atrioventricular block and atrial fibrillation are associated with a poorer prognosis. However, this was not confirmed by others[6]. Atrial fibrillation was found to have an impact on the survival prognosis at univariate analysis, but not at multivariate analysis, suggesting that it can represent only an innocent bystander associated with the progression of the disease rather than an independent risk factor[26].

Presence of ventricular tachycardia. Ventricular ectopic beats and NSVT are common in idiopathic DCM patients (35-53%)[4,6]. Although their ubiquity makes their significance difficult to assess, some studies demonstrated their prognostic value[6,31]. Grimm et al.[6] found in 202 patients NSVT and a left ventricular end-diastolic diameter > 70 mm as the only independent predictors that were associated with a 14-fold increased risk for future arrhythmic events. Nevertheless, others have failed to confirm this finding[4,30]. Teerlink et al.[31] have examined whether ventricular arrhythmias were independent and specific predictors using data from the Prospective Randomized Milrinone Survival Evaluation (PROMISE). They found that the variables of the frequency of premature ventricular contractions, presence of NSVT, frequency of NSVT and the duration of the longest run of NSVT were significant independent predictors of both overall mortality and SCD, with the frequency of NSVT being the most powerful.

Patients with spontaneous sustained VTs fare the worst and previous studies demonstrated the efficacy of the ICD in the secondary prevention of SCD[32-34]. However, despite ICD implantation, the survival of patients with VTs stored in the ICD is significantly impaired compared with that of patients without VTs[4,33]. Moreover, according to the study of Bansch et al.[17], only 16% of patients with clusters of VTs survived or did not undergo heart transplantation within 4 years of the first cluster of VT, as opposed to 80% of patients without VT clusters. Probably, the recurrence of VTs may be associated with an overall deterioration and progression of idiopathic DCM.

Signal-averaged electrocardiogram. An abnormal signal-averaged electrocardiogram (SAECG) appears to be correlated with the extent of myocardial fibrosis and the incidence of late potentials is lower in idiopathic DCM than in CAD patients. Mancini et al.[25] in their group of 114 patients have found time-domain analysis of the SAECG to be a useful factor for risk stratification with a 100% sensitivity and a positive predictive accuracy of 45% for subsequent arrhythmic events. Similarly, in a recent study including 76 patients, an abnormal SAECG was found to be associated with a 3.7-fold increased risk for SCD[7]. However, others have failed to demonstrate the prognostic value of SAECG[6,35-37].

Spectral turbulence analysis of the SAECG was found to be independently associated with a higher overall mortality in idiopathic DCM[38]. However, it has been observed that an abnormal spectral turbulence analysis is not an independent risk marker in idiopathic DCM but rather reflects a more advanced cardiac disease state[6].

Twelve-lead electrocardiogram. Recently, Iuliano et al.[39] found that QRS prolongation (> 120 ms) is an independent predictor of both an increased total mortality and SCD in CHF (ischemic and nonischemic). It has also been reported that a prolonged QTc interval (> 440 ms) was a strong predictor of both pump failure and SCD in patients with heart failure and B-type natriuretic peptide (BNP) levels > 400 pg/ml. The predictive value of a prolonged QTc interval was independent of that of concomitant QRS abnormalities[40].

An increased heterogeneity of ventricular repolarization during progressive heart failure favors the development of serious ventricular arrhythmias. Fei et al.[41] in 76 patients with idiopathic DCM did not find QT dispersion to be a predictor for arrhythmic events or death. In contrast, Grimm et al.[42] found that QT dispersion is significantly higher in those patients who develop arrhythmic events, but because of a large overlap between patients with and without subsequent arrhythmic events, the clinical value of this tool is limited. Interestingly, a study reported that QRS and QT dispersion were both independent predictors of non-SCD, and QRS dispersion was also an independent predictor of SCD[43]. The lack of the prognostic significance of QT dispersion may be inherent to the difficulty encountered in accurately determining the dispersion of repolarization from the surface ECG.

Heart rate variability and baroreflex sensitivity. A decreased baroreflex sensitivity and reduced heart rate variability after myocardial infarction have been shown to be associated with an adverse prognosis. Conversely, the available data on the cardiac autonomic tone in patients with idiopathic DCM are limited. A decreased heart rate variability and particularly a reduced standard deviation of all normal to normal intervals have been reported as independent predictors for arrhythmic

events and SCD in idiopathic DCM[23]. In 178 patients with CHF (40 with nonischemic DCM) the impairment of the heart rate variability variables was correlated with an increased risk of SCD and heart rate variability appeared to have an independent prognostic value in CHF[44]. Yi et al.[45] showed that heart rate variability is reduced in patients with nonischemic DCM and is also related to the disease severity.

On the other hand, Hoffmann et al.[46] in 71 patients with nonischemic DCM did not find the heart rate variability to be a valuable tool for predicting major arrhythmic events, including SCD. However, the same group[47] reported that heart rate variability, baroreflex sensitivity, and left ventricular ejection fraction had a weak to moderate correlation with each other, thus suggesting that they may have been of independent prognostic value in this population. Mortara et al.[48] observed among patients with CHF (50% with ischemic heart disease) a significantly higher mortality in those with a markedly reduced baroreflex sensitivity.

T wave alternans. Microvolt T wave alternans constitutes a new promising method for the prediction of arrhythmic events in idiopathic DCM[49]. In a recent study the onset heart rate for positive T wave alternans < 100 b/min showed the highest positive and negative predictive values (37.5 and 94.9% respectively) when compared with other noninvasive methods[50]. Despite these encouraging results, the determination of T wave alternans is not possible in all patients and confirmation on larger groups of patients is needed.

In view of the differences in the results of the various published studies, the ongoing MACAS trial[51] has been designed to provide more insight into the utility of these noninvasive risk stratification methods in idiopathic DCM.

Syncope. Syncope is one the most powerful risk predictors of the overall mortality and SCD[52-54]. Different trials have shown a high incidence of appropriate ICD shocks in 30-50% of patients with idiopathic DCM and unexplained syncope[14,15]. Grimm et al.[55] compared the incidence of appropriate ICD interventions for VT or VF in idiopathic DCM patients with NSVT and an ejection fraction < 30%, versus patients with syncope and patients with a history of VT or VF. Despite the different clinical presentations, the incidence of appropriate ICD interventions was similar in all three groups of patients (approximately 35%). Although these data suggest that prophylactic ICD implantation is beneficial in patients with syncope, precise exclusion of the known causes of syncope is required and none of these trials were conducted to examine whether the device can improve the overall mortality.

Plasma B-type natriuretic peptide. BNP, released from the ventricles in proportion to the intraventricular pressure or ventricular stretching, is elevated in patients with heart failure. The plasma BNP levels continue to increase along with the progression of left ventricular dysfunction. Several studies demonstrated that BNP levels are a particularly sensitive marker of ventricular damage and the plasma levels of this peptide have a prognostic role[40,56-58]. Berger et al.[58] have demonstrated that plasma BNP levels are an independent predictor of SCD in patients with heart failure and a left ventricular ejection fraction < 35% (19% of SCD in patients with BNP levels > 130 pg/ml vs 1% of SCD in patients with BNP levels below this cut-off). Recently, Vrtovec et al.[40] have found that patients with BNP levels > 400 ng/ml and with a prolonged QTc interval (> 440 ms) have an increased risk of pump failure death and SCD. At 6 months, including only patients with BNP levels > 400 ng/ml, the all-cause mortality rate was significantly higher in the prolonged QTc group (32%) than in the normal QTc group (6%). The same held true for the pump failure mortality (18 vs 2%) and SCD mortality (12 vs 2%).

Electrophysiological study. In patients with CAD and documented VT, the sensitivity of EPS is well defined and approaches 95%. In contrast, the percentage of nonischemic DCM patients in whom it is possible to induce VT varies between 0 and 100%, depending on the clinical presentation of the patients and on their physical status (Table I)[4,24,37,59-71]. Pooled data from available studies show that among patients presenting with NSVT alone, sustained ventricular tachyarrhythmias (sustained monomorphic VT or VF) can be induced in approximately 20%. In patients presenting with sustained VT and VF, ventricular tachyarrhythmias can be induced in almost 70 and 50%, respectively (Table II). Overall, only approximately 60% of nonischemic DCM patients presenting with either sustained VT or VF are inducible at EPS. This relatively low induction rate can be explained by the fact that the mechanism of arrhythmia in idiopathic DCM patients is partially different from reentry and therefore may not be targeted during "conventional" EPS.

The relative paucity and heterogeneity of data concerning the value of EPS in idiopathic DCM patients do not allow us to draw definite conclusions. Generally, risk stratification using EPS is problematic because of the low sensitivity of the method and owing to the high incidence of arrhythmic events in patients without inducible sustained VT. During the last three decades different studies used various stimulation protocols with a variable "degree of aggressiveness", ranging from only two extrastimuli to the right ventricular apex to three extrastimuli in both the right and left ventricles and continuous infusion of isoproterenol during stimulation. Moreover, all of these studies[4,24,37,59-71] were significantly limited with respect to the reported mortality and incidence of arrhythmic events during follow-up: 1) class I antiarrhythmic therapy mostly given to patients in the pre-CAST era, 2) empirically selected an-

Table I. Published results of the electrophysiological study (EPS) in patients with idiopathic dilated cardiomyopathy.

	Patient characteristics							Mode of EPS				Results of EPS		
	No.	Sex (M/F)	EF (%)	NSVT (≥ 3 VPB)	VT	VF or CA	Syncope	ES	Burst	Isoprenalin	Stimulation site	SMVT	SPVT	VF
Meinertz et al.[59], 1985	42	38/4	30-50*	13	2	0	NA	2	N	N	RVA	0	0	1
Das et al.[62], 1986	24	16/8	25 ± 12	11	0	0	0	3	N	N	RVA, RVOT	1	2	2
Poll et al.[61], 1986	47	30/17	28 ± 9	20	13	14	NA	3	Y	N	RVA, RVOT, LV	16	4	4
Stamato et al.[60], 1986	15	12/3	17 ± 8	14	0	0	0	2	Y	N	RVA, RVOT	0	0	0
Rae et al.[71], 1987	38	30/8	35 ± 15	15	11	3	7	3	N	N	RVA, RVOT	18	0	7
Liem and Swerdlow[69], 1988	64	45/19	30 ± 11	0	44	20	NA	3	Y	Y	RVA, RVOT, IAP	41	0	2
Milner et al.[66], 1988	19	12/7	26 ± 9	0	9	10	1	3	Y	N	RVA, RVOT	10	0	2
Constantin et al.[70], 1989	31	24/7	29 ± 8	0	16	11	4	3	Y	Y	RVA, RVOT, LV	19	NA	NA
Gossinger et al.[63], 1990	32	30/2	9-49*	32	0	0	0	3	N	N	RVA	4	3	0
Brembilla-Perrot et al.[64], 1991	103	87/16	27 ± 10	42	11	0	21	3	Y	Y	RVA, RVOT, IAP	18	0	1
Lindsay et al.[68], 1992	21	NA	20 ± 7*	21	0	0	0	NA	Y	N	RVA, RVOT	3	3**	–
Kadish et al.[65], 1993	43	37/6	26 ± 14	43	0	0	0	3	N	N	RVA, RVOT	6	NA	NA
Chen et al.[67], 1994	102	78/24	37 ± 13	0	63	39	NA	3	N	Y	RVA, RVOT	41	0	16
Turitto et al.[37], 1994	80	65/15	27 ± 8	80	0	0	14	3	N	N	RVA, RVOT	10	0	7
Grimm et al.[24], 1998	34	32/2	25 ± 6	34	0	0	6	3	N	N	RVA, RVOT	3	10**	–
Bansch et al.[4], 2002	104	83/21	24 ± 7	55	0	0	NA	NA	NA	NA	NA	3	0	10

CA = cardiac arrest; EF = ejection fraction; ES = number of extrastimuli; IAP = incremental atrial pacing; LV = left ventricle; N = not used; NSVT = nonsustained ventricular tachycardia; NA = not available; RVA = right ventricular apex; RVOT = right ventricular outflow tract; SMVT = sustained monomorphic ventricular tachycardia; SPVT = sustained polymorphic ventricular tachycardia; VF = ventricular fibrillation; VPB = ventricular premature beats; Y = used. * approximate values; ** included also VF.

Table II. Relationship between presenting and induced ventricular tachyarrhythmias.

Presenting arrhythmia	Arrhythmia induced during EPS		
	SMVT	SPVT or VF	NSVT or VPB
NSVT (n=256)	25 (10%)	31 (12%)	200 (78%)
Sustained VT (n=142)	88 (62%)	12 (8%)	42 (30%)
VF (n=83)	28 (34%)	12 (14%)	43 (52%)

EPS = electrophysiological study; NSVT = nonsustained ventricular tachycardia; SMVT = sustained monomorphic ventricular tachycardia; SPVT = sustained polymorphic ventricular tachycardia; VF = ventricular fibrillation; VPB = ventricular premature beats.

tiarrhythmic treatment in patients with noninducible ventricular arrhythmias[65,67], 3) small sample size and short follow-up period, 4) inhomogeneous enrolment criteria and patient selection with respect to the etiology of nonischemic DCM and presenting arrhythmia, 5) problematic interpretation of SCD, which being based on the experience in patients with CAD and VT, was assumed to be arrhythmic and due to VT or VF despite the fact that in patients with idiopathic DCM even electromechanical dissociation and bradyarrhythmias play an important role[18], 6) unreliable diagnosis of idiopathic DCM[63], and 7) the retrospective methodology of many of these studies.

Besides, other questions may be raised. Certain morphologies and axis orientations of inducible tachycardia can be associated with clusters of VT and multiple ICD shocks during follow-up[17] and this has not been stressed previously. Similarly, the specificity of induction of polymorphic VT or VF during EPS is unresolved. Although the clinical significance of polymorphic VT or VF induction has never been evaluated in large prospective studies with sufficient power in the idiopathic DCM setting, current data suggest that this is only a nonspecific response to a more aggressive stimulation protocol. Chen et al.[67] found in their cohort of 102 patients that as many as one third of patients with idiopathic DCM had cardiac arrest due to documented VF. They were not able to demonstrate any relation between induced and documented ventricular tachyarrhythmias (VT or VF) while in none of the patients (n = 16) in whom VF was induced during EPS did SCD occur during a mean follow-up of 32 ± 15 months. The latter observation was also confirmed by other investigators[33].

Primary prevention of sudden cardiac death

Current trends in the management of patients with CAD, ventricular arrhythmias and a depressed left ventricular function stress the superiority of ICD implant over antiarrhythmic treatment in primary prevention[72,73]. This superiority of the ICD in primary prevention was not found in idiopathic DCM patients with a depressed left ventricular function. Recently, the German Cardiomyopathy Trial (CAT) failed to prove any benefit of prophylactic ICD implantation in patients with recent-onset idiopathic DCM and an impaired left ventricular ejection fraction (≤ 30%). The cumulative actuarial survival rate in the CAT trial was 92, 86, and 73% in the ICD group versus 93, 80, and 68% in the control group after 2, 4, and 6 years respectively[4]. The AMIOVIRT trial did not prove the superiority of the ICD over amiodarone in idiopathic DCM patients with NSVT. The survival rates were 88 and 85% in the amiodarone-treated group versus 89 and 79% in the ICD group after 2 and 4 years, respectively[74]. Both trials were only pilot studies without sufficient power to clarify the role of prophylactic ICD implantation in idiopathic DCM with any certainty. Furthermore, as previously stated, the risk of SCD in these patients is related to the time of observation (patient at the first observation?, patient evaluated after a long period of follow-up with optimal medical therapy and severe left ventricular dysfunction?). Therefore, the type of population considered in each trial could have significantly affected the survival rates and the effectiveness of the ICD in primary prevention.

Relevant information will be available after the termination of two ongoing primary prevention trials: the Sudden Cardiac Death Heart Failure Trial (SCD-HEFT) and the Defibrillators in Nonischemic Cardiomyopathy Treatment Evaluation (DEFINITE)[75,76]. The SCD-HEFT is studying patients with either idiopathic DCM or a myopathy due to CAD with ejection fraction < 35%. Patients are being randomized to conventional therapy, amiodarone therapy, or the ICD. The DEFINITE is including idiopathic DCM patients with ejection fraction < 35% and NSVT or > 10 premature ventricular contractions/hour. Patients are being randomized to an ICD versus no ICD.

Conclusions

SCD in idiopathic DCM patients can be caused by both bradycardia and ventricular tachyarrhythmia and its mechanism may be attributed to a broad spectrum of etiologies partially different from CAD. Several invasive and noninvasive methods have been evaluated in the risk stratification of this population, but the results obtained so far are controversial. To date, there are no specific guidelines. Figure 1 shows the approach used in our institution in the risk stratification of patients with idiopathic DCM.

The identification of high-risk patients with moderate disease still remains puzzling and thus, further trials that will bring more insight into risk stratification are needed.

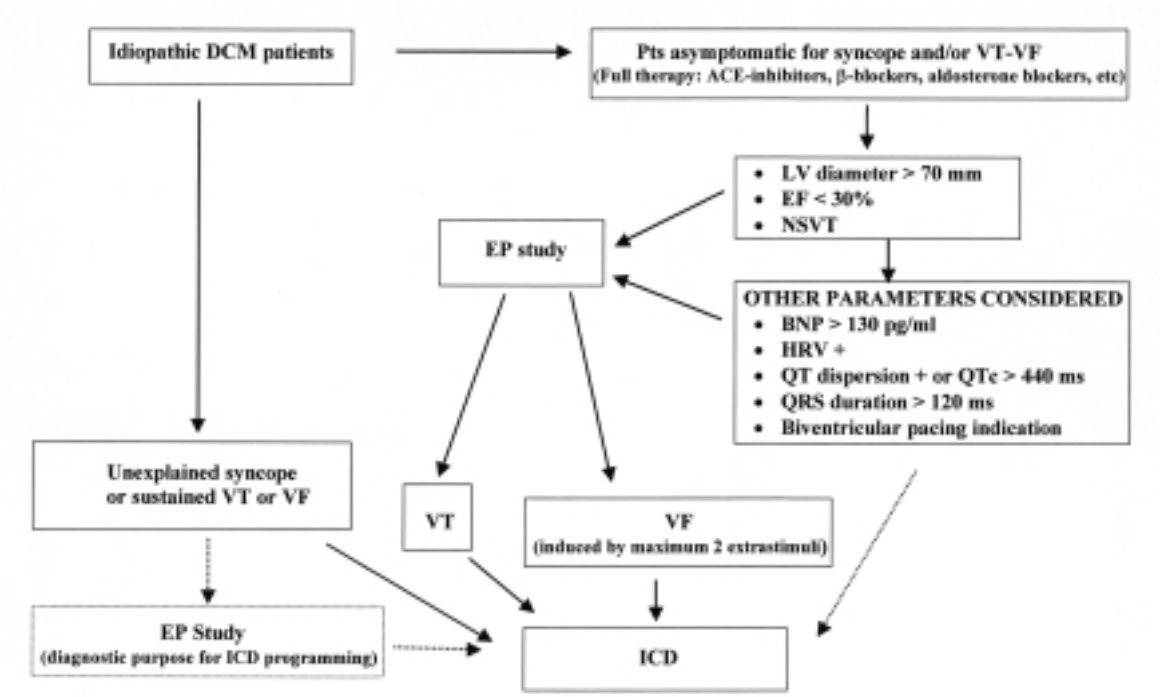

Figure 1. *The flow-chart shows the approach used in our institution in the risk stratification of patients with idiopathic dilated cardiomyopathy (DCM).* Dotted lines *show an optional indication. BNP = B-type natriuretic peptide; EF = ejection fraction; EP = electrophysiological; HRV = heart rate variability; ICD = implantable cardioverter-defibrillator; LV = left ventricular; NSVT = nonsustained ventricular tachycardia; VF = ventricular fibrillation; VT = ventricular tachycardia. + = positive.*

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