Efficacy and Limitations of Tachycardia Detection Interval Guided Reprogramming for Reduction of Inappropriate Shock in Implantable Cardioverter-Defibrillator Patients

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SUMMARY

The avoidance of inappropriate shock therapy is an important clinical issue in implantable cardioverter-defibrillator (ICD) patients. We retrospectively analyzed therapeutic events in ICD patients, and the effect of tachycardia detection interval (TDI) and tachycardia cycle length (TCL) guided reprogramming on the reduction of inappropriate ICD therapy. The clinical determinants of after reprogramming were also evaluated.

A total of 254 consecutive ICD patients were included in the study, and the incidence of antitachycardia therapy was evaluated during the follow-up period of 27.3 ± 18.7 months. When inappropriate antitachycardia therapy appeared, TDI was reprogrammed not to exceed the detected TCL and the patients continued to be followed-up. Various clinical parameters were compared between patients with and without inappropriate ICD therapy. During the initial follow-up period of 18.6 ± 15.6 months, ICD therapy occurred in 127/254 patients (50%) including inappropriate antitachycardia pacing (ATP) (12.9%) and shock (44.35%). Determinants of initial inappropriate therapy were dilated cardiomyopathy (DCM), history of therapeutic hypothermia, and QRS duration. Of the 61 patients with inappropriate therapy, 24 received TCL guided reprogramming. During the additional observation period of 17.0 ± 16.8 months, inappropriate therapy recurred in 5/24 patients (2 ATP, 3 shocks). The determinant of these inappropriate therapy events after reprogramming was the presence of supraventricular tachycardia.

By applying simple TCL and TDI guided reprogramming, inappropriate therapy was reduced by 79%. The determinant of inappropriate therapy after reprogramming was the presence of supraventricular tachycardia. (Int Heart J 2016; 57: 304-309)

Key words: Inappropriate therapy, Tachycardia detection interval, Supraventricular tachycardia

The implantable cardioverter-defibrillator (ICD) is highly effective in reducing mortality due to ventricular tachyarrhythmia among high-risk patients with cardiovascular diseases.¹⁻³ Since the 1980s, ICDs have been introduced to prevent sudden cardiac death,⁴ and their benefits have been demonstrated in large clinical trials.⁵⁻⁸ However, apart from the various clinical benefits of ICD, inappropriate therapies can be caused by the misdetection of supraventricular tachyarrhythmia (SVT) as target ventricular tachycardia or fibrillation (VT/VF) in some cases, and the incidence of inappropriate therapy is reported to be 8-40% despite various medical treatments.⁹ Inappropriate shock therapies are painful, anxiety-inducing, and impair patient quality of life; they may also worsen the prognosis due to myocardial damage caused by repeated shock therapies.^{10,11} Therefore, inappropriate shock therapy should be avoided in ICD patients as much as possible. We have previously reported that the maximal heart rate during the exercise stress test is a predictor for future events of inappropriate ther-

apy in ICD patients.¹² Other investigators have also demonstrated other predictors for inappropriate shock therapy, including a history of atrial fibrillation (AF) or an age younger than 70 years,¹³ and reported that high-zone settings of ICD shock therapy are useful for reducing inappropriate therapy.^{14,15} However, the effect of a specific ICD reprogramming method for reducing inappropriate therapy has not been well evaluated. In the present study, we retrospectively analyzed therapeutic events in ICD patients and evaluated the effect of simple tachycardia detection interval (TDI) and tachycardia cycle length (TCL) guided reprogramming on the reduction of inappropriate ICD therapy. We also evaluated the clinical determinants for such therapies after reprogramming.

METHODS

Study population: The study population consisted of 254 con-

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Figure 1. Results of the follow-up of patients in the primary and secondary observations. This figure shows a schematic of the grouping of the patients during the primary and secondary observations. During the initial observation of 18.6 ± 15.6 months, ICD therapy was observed in 127/254 patients. The 61 patients with inappropriate therapies underwent TCL-TDI guided reprogramming ($n = 24$) or additional rate or rhythm control prescription ($n = 26$), and continued to be followed up. See text for details. ATP indicates antitachycardia pacing; TCL, tachycardia cycle length; and TDI, tachycardia detection interval.

secutive ICD patients. All patients underwent ICD implantation and were followed-up at Kitasato University Hospital from February 2002 to July 2014. The ICD was indicated for the primary prevention of VT/VF in 52/254 patients. In the remaining 202/254 patients, the ICD was indicated for the secondary prevention (VT 59, VF 118, and others 25 patients). The average observation period after the initial ICD implantation was 26.0 ± 18.7 months in patients with the purpose of secondary prevention.

Initial observation: They were followed up until the first ICD actuation in patients with a therapeutic episode ($n = 127$) or for 36 months in patients with no therapeutic episode ($n = 127$, Figure 1). The patients were then divided into 3 groups with appropriate therapies, inappropriate therapies, and no therapy during the initial observation. In patients with inappropriate therapies, a tachycardia detecting algorithm was reprogrammed in accordance with the following procedure. First, we attempted to set TDI so as not to exceed the detected tachycardia cycle length, ie, simple TCL-TDI guided reprogramming. If this change was difficult, an oral medicine, such as a beta-blocker, was additionally prescribed depending on the patient situation. A typical reason for difficulty in the simple TCL-TDI guided reprogramming was the overlap of the highest sinus tachycardia rate and clinical VT/VF rate. In such cases, simple TCL-TDI guided reprogramming could not be indicated to avoid inappropriate suppression of truly needed therapy.

Secondary observation: After this modification procedure, the patients continued to be followed up to evaluate further therapeutic episodes in a similar way to the initial observation. In accordance with the therapeutic results during this observation, the patients were divided further into 3 groups in the same way as the initial observation (Figure 1). Clinical parameters were compared among these 3 patient groups to determine predicting factors for appropriate and/or inappropriate ICD therapies.

ICD devices and initial programming: All defibrillator systems were implanted in the pectoral region, and all leads were successfully implanted via a transvenous approach without us-

ing thoracotomy lead systems. The numbers of patients with dual and single chamber ICD were 239 and 15, respectively. During the implantation procedure, routine tests for pacing, sensing, and defibrillation threshold measurements were performed. Patients were basically followed up under the same 2-zone therapeutic setting, ie, one VT zone and one VF zone. The tachycardia and fibrillation detection interval (TDI/FDI) employed default settings (TDI of 420-430 ms and FDI of 300 ms). Device interrogations were repeated every 4 months in the device outpatient clinic. Basically, all patients were followed up under the initial setting until the first ICD actuation. When the first ICD actuation was observed, the appropriateness of each therapy was determined through the interrogation of the episode. In cases with inappropriate therapies, TCL-TDI guided reprogramming was indicated as much as possible. Because reprogrammed TDI and FDI were determined by referring detected tachycardia cycle length, they have varied among individual patients.

The ICD therapy was defined as either anti-tachycardia pacing (ATP) or ICD shock. The ICD therapy was analyzed by comparing records in the ICD memories and interrogated intracardiac electrograms. A case in which the ICD therapy was performed except for VT or VF was determined as a patient with inappropriate therapy. The rhythm that triggered therapeutic actuation was categorized as SVT including sinus tachycardia, AF, or atrial flutter (AFL).

Statistics: All values are expressed as the mean $\pm$ standard deviation. The baseline characteristics were compared among patient groups using chi-square tests for binary variables and the Tukey-Kramer test for continuous variables. Predictors of inappropriate therapies were determined by univariate analyses using logistic regression and the Cox hazard model. In all tests, significance was determined at a P value < 0.05 . Statistical analysis was performed with JMP statistical software (SAS institute Inc., Cary, NC, USA).

Table I. Clinical Characteristics of Patients With and Without ICD Therapeutic Episodes

	All (<i>n</i> = 254)	No therapy (<i>n</i> = 127)	Appropriate therapy (<i>n</i> = 66)	Inappropriate therapy (<i>n</i> = 61)	<i>P</i>
Age (years)	57.7 ± 14.7	59.4 ± 14.9	57.0 ± 14.0	54.9 ± 14.9	0.1293
Sex, males, <i>n</i> (%)	211 (83)	105 (83)	56 (85)	50 (82)	0.8980
CPA, <i>n</i> (%)	140 (56)	61 (48)	39 (59)	40 (66)	0.0772
Therapeutic hypothermia, <i>n</i> (%)	65 (26)	31 (24)	9 (14)	25 (41)	0.0019*
BMI (kg/m ²)	23.3 ± 8.2	22.8 ± 9.0	24.5 ± 9.5	23.2 ± 3.5	0.4675
Primary, <i>n</i> (%)	52 (20)	34 (27)	5 (8)	13 (21)	0.0072*
Dual chamber, <i>n</i> (%)	239 (94)	124 (98)	59 (89)	56 (92)	0.0481*
Cardiovascular disease					
IHD, <i>n</i> (%)	49 (21)	32 (25)	12 (18)	5 (9)	0.0355*
DCM, <i>n</i> (%)	26 (10)	7 (6)	6 (9)	13 (21)	0.0036*
HCM, <i>n</i> (%)	11 (4)	5 (4)	3 (5)	3 (5)	0.9485
Brugada, <i>n</i> (%)	66 (26)	36 (28)	19 (29)	11 (18)	0.2667
Risk factor					
Hypertension, <i>n</i> (%)	105 (41)	49 (39)	30 (45)	26 (43)	0.6375
Diabetes, <i>n</i> (%)	53 (21)	27 (21)	14 (21)	12 (20)	0.9659
Dyslipidemia, <i>n</i> (%)	90 (35)	47 (37)	22 (33)	21 (34)	0.8642
Smoking, <i>n</i> (%)	141 (65)	72 (57)	37 (56)	32 (60)	0.6568
ECG parameters					
HR (bpm)/implant	71.0 ± 19.5	69.0 ± 16.2	70.0 ± 21.6	76.7 ± 23.8	0.1051
QRS (msec)/implant	114.4 ± 28.1	115.3 ± 30.3	122.9 ± 30.9	104.9 ± 13.9	0.0375*
QTc (msec)/implant	434.2 ± 56.5	435.0 ± 47.4	425.7 ± 87.7	438.6 ± 48.7	0.6604
Laboratory data					
BNP (pg/mL)	186.8 ± 431.1	160.0 ± 234.0	187.8 ± 431.0	238.7 ± 676.5	0.7378
LDL (mg/dL)	103.6 ± 32.7	97.8 ± 32.3	109.4 ± 29.9	110.5 ± 34.7	0.1149
HbA1c (%)	7.1 ± 13.8	8.5 ± 19.5	5.8 ± 1.1	5.5 ± 0.6	0.5995
Chest X-p					
CTR (%)	51.0 ± 7.4	49.9 ± 7.0	53.4 ± 9.0	51.7 ± 6.3	0.0405*

CPA indicates cardiopulmonary arrest; BMI, body mass index; IHD, ischemic heart disease; DCM, dilated cardiomyopathy; HCM, hypertrophic cardiomyopathy; HR, heart rate; BNP, brain natriuretic peptide; LDL, low density lipoprotein; HbA1c, hemoglobin A1c; CTR, cardio-thoracic ratio. **P* < 0.05 among the three groups of no therapy, appropriate therapy, and inappropriate therapy.

RESULTS

Initial observation: During the initial follow-up period of 18.6 ± 15.6 months, ICD therapy was observed in 127/254 patients (50%). There was no “under-detection” case of clinical VT/VF due to the shortening of TDI. Among these therapeutic episodes, inappropriate therapies were 61/127 (48%), and they consisted of 12 inappropriate ATP and 44 inappropriate shock. The therapies could not be specified in the remaining 5 cases. Inappropriate therapies were triggered by SVT in 33/61 (54%), AF/AFL in 23/61 (38%), and others in 5/61 patients (8%). Table I shows the clinical characteristics of all 254 patients and a comparison among patients with different types of ICD therapeutic episodes during the initial observation. Among various clinical parameters, patients with inappropriate therapy showed a higher incidence of therapeutic hypothermia and DCM, and a lower incidence of ischemic heart disease. An ECG parameter showed shorter QRS duration in patients with inappropriate therapies than the others.

Secondary observation: In the reprogramming of 61 patients with inappropriate therapies, TCL-TDI guided reprogramming was applicable in 24 patients. In 24 patients, the oral medication was administered in 6 patients. Specifically, a beta-blocker was administered in 3, digoxin in 1, and a class III and IV antiarrhythmic agent in one patient each. In 26 patients, additional rate control therapy (beta-blocker, *n* = 9) or rhythm control therapy (class III antiarrhythmic agent and others, *n* = 17) was prescribed. ICD therapy was not modified in the remaining 11

patients because of the patient situations. During the secondary observation of 17.0 ± 16.8 months, inappropriate therapies were observed in 5 of 24 and 9 of 26 patients with and without TCL-TDI guided reprogramming, respectively. Figure 2 shows the number of therapies observed in these 50 patients. In patients with TCL-TDI guided reprogramming, the incidence of inappropriate therapies was reduced by 79%. In patients without TCL-TDI-guided reprogramming, the incidence of inappropriate therapies was reduced by 65%. Figure 3 shows the causes of inappropriate therapy after reprogramming. The main cause of inappropriate therapy was SVT or AF in both patients with and without TCL-TDI guided reprogramming. The incidence of AF tended to be smaller in patients with TCL-TDI guided reprogramming, but there was no significant difference between the patients with and without TCL-TDI guided reprogramming.

Comparison of patients with and without ICD therapeutic episodes after TCL-TDI guided reprogramming: Table II shows a comparison of patients with and without ICD therapeutic episodes in the small subgroup of patients with TCL-TDI guided reprogramming. Among various parameters, the incidences of therapeutic hypothermia and SVT were higher in patients with inappropriate therapy than the others. Multivariate analysis was not performed because of the small number of patients (*n* = 5).

Figure 2. Number of therapies before and after reprogramming. In patients with TCL-TDI guided reprogramming, the incidence of inappropriate therapies was reduced by 79%. On the other hand, in patients without TCL-TDI-guided reprogramming, the incidence of inappropriate therapies was reduced by 65%. See text for details. The meaning of “no therapy” is the absence of both clinical VT/VF and inappropriate therapy. AT indicates appropriate therapy; IT, inappropriate therapy; and NT, no therapy.

Figure 3. The cause of inappropriate therapy after reprogramming. The main cause of inappropriate therapy was SVT or AF in both patients with and without TCL-TDI guided reprogramming, but the incidence of AF was lower in patients with TCL-TDI guided reprogramming. See text for details. SVT indicates supraventricular including sinus tachycardia; and AF/AFL, atrial fibrillation or flutter.

Table II. Clinical Characteristics of Patients With and Without ICD Therapeutic Episodes after TCL-TDI Guided Reprogramming

	All (n = 24)	No therapy (n = 17)	Appropriate therapy (n = 2)	Inappropriate therapy (n = 5)	P
Age (years)	55.7 ± 15.9	57.4 ± 15.5	53.5 ± 10.6	50.6 ± 20.3	0.7058
Sex, males, n (%)	20 (83)	15 (88)	2 (100)	3 (60)	0.2653
CPA, n (%)	18 (75)	11 (65)	2 (100)	5 (100)	0.1926
Therapeutic hypothermia, n (%)	11 (46)	5 (29)	2 (100)	4 (80)	0.0376*
BMI (kg/m ²)	23.6 ± 3.9	23.1 ± 2.6	18.2	26.2 ± 5.6	0.1083
Primary, n (%)	3 (13)	3 (18)	0 (0)	0 (0)	0.4937
Dual chamber, n (%)	20 (83)	13 (76)	2 (100)	5 (100)	0.3722
Cardiovascular disease					
IHD, n (%)	3 (13)	3 (18)	0 (0)	0 (0)	0.5214
DCM, n (%)	3 (13)	2 (12)	1 (50)	0 (0)	0.1926
HCM, n (%)	1 (4)	0 (0)	0 (0)	1 (20)	0.1377
Brugada, n (%)	3 (13)	3 (18)	0 (0)	0 (0)	0.4937
Risk factor					
Hypertension, n (%)	12 (50)	9 (53)	1 (50)	2 (40)	0.8786
Diabetes, n (%)	4 (17)	2 (12)	1 (50)	1 (20)	0.3802
Dyslipidemia, n (%)	6 (25)	4 (24)	0 (0)	2 (40)	0.5256
Smoking, n (%)	12 (50)	8 (47)	1 (50)	3 (60)	0.5170
ECG parameters					
HR (bpm)/implant	88.1 ± 29.3	81.9 ± 28.4	105	102.5 ± 33.1	0.4258
QRS (msec)/implant	101.9 ± 10.4	100.9 ± 11.2	99	108.5 ± 4.9	0.6464
QTc (msec)/implant	438.1 ± 39.9	425.5 ± 23.1	453	479.3 ± 70.3	0.1013
Laboratory data					
BNP (pg/mL)	318.4 ± 892.4	375.0 ± 1076.9	20.4	237.1 ± 256.5	0.9209
LDL (mg/dL)	104.4 ± 28.7	107.5 ± 30.6	-	89.0 ± 8.5	0.4312
HbA1c (%)	5.3 ± 0.5	5.3 ± 0.4	4.7	5.8 ± 1.0	0.2428
Chest X-p					
CTR (%)	50.2 ± 7.0	49.3 ± 7.4	49	53.0 ± 6.6	0.6774
The cause of inappropriate therapy before reprogramming					
SVT, n (%)	10 (42)	4 (24)	2 (100)	4 (80)	0.0457*
AF/AFL, n (%)	10 (42)	9 (52)	0 (0)	1 (20)	0.1124
Others, n (%)	4 (16)	4 (24)	0 (0)	0 (0)	0.3012

CPA indicates cardiopulmonary arrest; BMI, body mass index; IHD, ischemic heart disease; DCM, dilated cardiomyopathy; HCM, hypertrophic cardiomyopathy; HR, heart rate; BNP, B-type natriuretic peptide; LDL, low density lipoprotein; HbA1c, hemoglobin A1c; CTR, cardio-thoracic ratio; SVT, supraventricular tachycardia including sinus tachycardia; and AF/AFL, atrial fibrillation or flutter. * $P < 0.05$ among the three groups of no therapy, appropriate therapy, and inappropriate therapy.

DISCUSSION

In our present study, the evaluation of the clinical deter-

minants of inappropriate therapy and the effect of TDI guided reprogramming revealed several interesting findings. First, the patients with inappropriate therapy during initial observation

were associated with therapeutic hypothermia, DCM, and ischemic heart disease. The ECG parameter was associated with QRS duration in patients with inappropriate therapies compared to the others. Second, the incidence of inappropriate therapy was reduced during the secondary observation in comparison with the initial observation both in the TCL-TDI guided reprogramming group and the other patient group with additional drug prescription. The reduction rates were 79% and 65%, respectively, although there was no statistical difference. Third, the appearance of inappropriate therapy even after the TCL-TDI guided reprogramming was correlated with the history of therapeutic hypothermia and the higher presence of SVT.

Predictors of inappropriate therapy during the initial observation: In the previous reports about the predictors for inappropriate shock during ICD therapy,^{14,15} several interesting factors have been listed, such as the absence of coronary artery disease, history of AF, single chamber ICD, no statin use, younger age, and history of smoking. Although the mechanisms of the associations between these factors and inappropriate therapy are not so simple, they can be summarized in 2 components. One is the higher physical activity and sympathetic nervous activity, and the other is the lack of preventive therapy for the underlying diseases. Most likely, the former can be related to a higher incidence of sinus tachycardia, and the latter to the progression of underlying diseases, which may lead to construction of an arrhythmogenic substrate for ventricular arrhythmic events. In the present study, the presence of a history of therapeutic hypothermia, DCM, and a lower incidence of ischemic heart disease were detected as predictors for inappropriate shock. They were almost compatible to the results in the previous reports, although the history of therapeutic hypothermia is a new finding. The precise mechanism is unclear, however, an impaired autonomic nervous system during this aggressive therapy may remain even after the recovery from the acute phase. The presence of such retained autonomic dysfunction in resuscitated patients is unclear, but Pfeifer, *et al* have reported that both sympathetic and vagal tones were reduced in patients after therapeutic hypothermia in comparison with the others when evaluated in terms of heart rate variability (HRV).^{16,17} Because a relationship between the arrhythmic event and reduced autonomic activity has been reported,¹⁸ the history of therapeutic hypothermia may contribute to the incidence of ICD therapy. As for the ECG parameter, shorter QRS duration was correlated with inappropriate shock. This may indicate a correlation between more normal subjects with higher physical activity and the higher incidence of sinus tachycardia in daily life because the majority of sinus tachycardia should be associated with catecholaminergic triggers such as emotions, physical activity, and other stresses.^{19,20}

Several studies have reported that dual chamber ICD decrease inappropriate therapies.^{21,22} Because the dual chamber ICD can record atrial and ventricular intracardiac electrograms, a dual chamber ICD can diagnose tachy-arrhythmias more accurately than a single chamber ICD. In the present study, the actual percentage of inappropriate therapy was smaller in dual chamber ICD than single chamber ICD, but this point of “dual/single chamber” was not an independent predictor in our evaluation. This is probably because of the relatively small number of patients with a single chamber ICD, but the present data suggests the usefulness of TCL-TDI guided reprogramming at

least in the population in whom the dual chamber system was mainly used.

Effect of ICD reprogramming on reducing inappropriate therapy: Whether it is appropriate or inappropriate therapy, ICD therapy increased the risk of myocardial injury and mortality.^{23,24} The patient's drivers license may be suspended for a considerable period,^{25,26} so inappropriate shock treatment should be reduced as much as possible. Several clinical studies have been performed to examine ICD programming to reduce ICD therapy.²⁷ In the Multicenter Automatic Defibrillator Implantation Trial to Reduce Inappropriate Therapy (MADIT-RIT),¹ it was reported that high-rate cut-off ICD programming was associated with a 79% risk reduction in the first occurrence of inappropriate therapy as compared to conventional ICD programming. To avoid the false detection of SVT and AF/AFL that might cause inappropriate therapy, the cutoff rate for tachycardia detection should ideally be programmed. We employed mostly the default setting for VT/VF therapy and the incidence of inappropriate therapy during the initial observation period was 24%, which was similar to previous reports.¹² Although our previous report suggests the possibility of predicting inappropriate therapy from the peak heart rate in an exercise stress test,¹² such clinical tests are difficult to manage in device-implanted patients, especially immediately after device implantation. We employed simple TCL-TDI guided reprogramming and it reduced inappropriate shock by 79% in the secondary observation (100% in initial versus 21% in secondary). The follow-up period of the initial and secondary observations were the same. Of course, although this number is dependent on the occasionally appearing arrhythmic events during both observation periods, this reduction rate is quite considerable. The alternative way to reduce inappropriate shock, ie, the additional prescription of beta-blockers and/or antiarrhythmic agents, also reduced the rate of inappropriate shock by 65%, which was slightly smaller in comparison with TCL-TDI guided reprogramming, although it did not reach statistical significance. The reprogramming protocol itself, ie, preferential choice of TCL-TDI guided reprogramming, may represent a selection bias, but our result may exhibit the possible superiority of simple TCL-TDI guided reprogramming to any type of pharmacological intervention, at least for the purpose of reduction of inappropriate shock therapy in ICD patients. The results of our study may indicate that TCL-TDI guided reprogramming is simple but still the most effective programming for patients with inappropriate therapy.

Predictors of inappropriate therapy even after the TCL-TDI guided reprogramming: To the best of our knowledge, there has been no report about the incidence and determinants of inappropriate therapy after systematic reprogramming following the initial inappropriate therapy. The main cause of inappropriate therapy after TCL-TDI guided reprogramming was the incidence of therapeutic hypothermia and the presence of SVT, which was similar to those before the reprogramming. van Rens, *et al* reported that the main cause of inappropriate therapy was the misdiagnosis of SVT,¹³ although their results were about the causes of first inappropriate therapy. Based on this result, it is necessary to avoid SVT as the most common cause of misdiagnosis as VT/VF in individual cases. A previous study reported that beta-blocker use was significantly associated with a reduction of inappropriate therapy for atrial tachycardia.²⁸ To reduce such confusing tachycardia, appropriate medi-

cation including beta-blockers and/or catheter ablation should be considered in addition to simple TCL-TDI guided reprogramming in patients with ICD.

Limitations: This study has several limitations. This was a retrospective and a single center study with a small number of patients. First, because this was a retrospective study, our results may not be accurately predictive for inappropriate therapy. Second, because the number of patients with inappropriate therapy after reprogramming is small, it is limited for statistical analysis and there may have been some selection bias as it was performed at a single institution. Finally, determination of the initial setting and reprogramming of the ICD was left to the physicians.

Conclusions: Applying a simple TCL-TDI guided reprogramming led to a 79% reduction in inappropriate therapy in patients. The determinant and cause of inappropriate therapy after reprogramming was the presence of supraventricular tachycardia. To reduce repeated inappropriate therapy, it is necessary to employ simple TCL-TDI guided reprogramming in addition to appropriate medication including beta-blockers and/or catheter ablation.

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