

Clinical Follow-up of Patients with Implantable Cardioverter-Defibrillator

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Objective: To report appropriate (AT) and inappropriate (IT) ICD therapies in patients with ischemic and nonischemic heart disease, as well as early and late procedure-related complications.

Methods: One hundred and fifty-five patients (119 male and 36 female), mean age 47 years (21-88), who underwent ICD implantation between 1994 and March 2003 were analyzed. Patients were divided into the following groups: Group I - Post-AMI patients (n = 80); Group II - Patients with nonischemic heart disease and LV ejection fraction < 40% (n = 45), Chagas disease (n = 18), idiopathic dilated cardiomyopathy (n = 12), hypertensive disease (n = 8), hypertrophic cardiomyopathy (n = 4) and valvular heart disease (n = 3); Group III - Patients with arrhythmogenic right ventricular dysplasia (n = 13); and Group IV - Patients with channelopathies: Brugada Syndrome (n = 8) and idiopathic ventricular arrhythmias (n = 9). All patients underwent EPS before ICD implantation.

Results: During the 26-month mean follow up, a high rate of appropriate ICD therapies (antitachycardia pacing and/or shock) was observed (46%) in the four groups, with no statistically significant difference. The four groups did not differ in either overall (8.4%) or arrhythmic mortality (1.3%). There was no correlation between appropriate ICD therapies and initial clinical presentation or inducible ventricular arrhythmia at EPS, and a 4% incidence of early and late procedure-related complications was found.

Conclusion: The high incidence of appropriate ICD therapy and low rate of sudden death in the patients studied suggest that ICD is a valuable strategy in the management of ischemic and nonischemic patients previously selected by means of EPS.

Key words: Sudden death, implantable cardioverter-defibrillator, appropriate and inappropriate discharges, ischemic and nonischemic heart disease.

Sudden death may be defined as an unexpected death that usually occurs less than one hour after the onset of symptoms in a subject without a known potentially fatal condition¹.

Sudden cardiac death (SCD) is the leading cause of death in developed countries, with an estimated incidence of 400,000 new cases per year in the United States alone^{1-5,7}, and accounts for 50% of all cardiovascular deaths^{2,4}.

Fifteen percent of the cases are associated with bradyarrhythmias, and SCD usually represents a final stage of heart failure and a form of irreversible electromechanical dissociation. More commonly, cardiac sudden death occurs after the onset of a rapid monomorphic ventricular tachycardia that degenerates into ventricular fibrillation⁶. Less frequently, polymorphic ventricular tachycardias and ventricular fibrillations are directly responsible for these episodes. Generally, polymorphic arrhythmias are the triggering events in patients with ion channel diseases³. Dilated

and hypertrophic cardiomyopathies, in turn, are the second leading cause of sudden cardiac deaths³, while idiopathic dilated cardiomyopathy accounts for 10% of the cases in the adult population.

Other cardiac disorders, such as congenital and valvular heart diseases, acquired infiltrative myocardial diseases, primary electrophysiological disorders, and genetic ion-channel diseases, notably known for their arrhythmogenic profile, account for a small percentage of sudden death cases^{2-5,7}.

Most people who suffer sudden cardiac death do not manifest specific prodromal signs or symptoms that may identify them as being at higher risk before the potentially fatal event⁴.

Therapeutic strategies aimed at preventing sudden death may be divided into two categories: primary and secondary prevention. Primary prevention refers to the attempt to prevent

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a first potentially fatal arrhythmic event, such as sustained ventricular tachycardia or ventricular fibrillation. The aim of secondary prevention is to prevent the recurrence of such events in patients with history of “resuscitated” or aborted sudden death after a first potentially fatal arrhythmic event⁵.

At first, strategies for preventing sudden death focused on suppressing ventricular ectopic activities (extrasystoles). It took many years for the medical practice to understand that the suppression of these asymptomatic arrhythmias was not only inappropriate but also dangerous^{8,9}.

Implantable cardioverter-defibrillator was first used in humans in 1980^{10,11}. By 1998, more than 50,000 ICDs had been implanted worldwide¹². Since then, this figure has been increasing on an exponential curve. These devices were approved by the FDA in 1985. Initially, its effectiveness was tested in observational studies¹³. Only in the 1990s, more than ten years after they had been approved for clinical use, were the first results of randomized and prospective studies about implantable cardioverter-defibrillators published^{13,14}.

The ICD benefit in reducing mortality in patients resuscitated from fatal arrhythmic events, that is to say, as secondary prevention, is beyond doubt¹⁵.

Objectives - To document the mid and long-term profile of appropriate and inappropriate ICD discharges in patients with ischemic and nonischemic heart diseases and those with less common diseases and no involvement of the left ventricular function, such as idiopathic ventricular arrhythmias, arrhythmogenic right ventricular dysplasia (ARVD), and Brugada syndrome and to report early and late implant-related complications.

Methods

One hundred and fifty-five patients (119 male and 36 female), mean age 47 (21 to 88) underwent ICD implantation between 1994 and March 2003 at the Hospital Universitário Clementino Fraga Filho of the Universidade Federal do Rio de Janeiro and at the Clínica São Vicente, Rio de Janeiro (Tab. 1).

Patients were previously selected from the outpatient clinic of these two hospitals. Anamnesis focused on previous

episodes of resuscitated sudden death, documented ventricular arrhythmias, syncope, presyncope, palpitations, history of myocardial infarction or angina, functional class, and other related symptoms. Family history of sudden death and/or death of relatives at young ages was routinely questioned. After a thorough clinical history, a resting 12-lead electrocardiogram and two-dimensional echocardiogram were requested mostly to assess the left ventricular ejection fraction and scarred areas from myocardial infarction. Based on clinical history, a 24-hour Holter and/or exercise testing were requested. Patients with hypertrophic cardiomyopathy were included in group II, because at the time of ICD implantation their left ventricular function was compromised, with LVEF < 40%. According to the structural heart disease and the presence or not of left ventricular dysfunction, patients were divided into four groups (Tab. 1).

Clinical characteristics of patients of group 4 are summarized in Tables 1 and 2.

All patients underwent EPS before implantation with induction of sustained ventricular arrhythmia (sustained monomorphic ventricular tachycardia, polymorphic ventricular tachycardia or ventricular fibrillation). Prior to EPS, it was mandatory that patients with suspected acute coronary ischemia be excluded through evaluation of anginal symptoms or cardiac catheterization in selected patients. The EPS was performed at the Electrophysiological Laboratories of the Hospital Universitário and Clínica São Vicente with specialized medical and nursing teams.

The protocol for ventricular stimulation was performed at the cycle lengths of 600, 500, and 430 ms using up to three extrastimuli delivered to the right ventricular apex and outflow tract, until a sustained ventricular arrhythmia was induced or not, as described in previous studies published in the literature^{16,19}. Inducible sustained ventricular arrhythmia at EPS was defined as monomorphic ventricular tachycardia, polymorphic ventricular tachycardia or ventricular fibrillation lasting 30 seconds or longer during the programmed ventricular stimulation, at any cycle, at the right ventricle apex or outflow tract and that reverted spontaneously or could be reverted with rapid ventricular stimulation or external defibrillation. After the EPS, patients remained in hospital for at least 12 hours.

ICD implantation - During the first two years, only single-

Patient Groups	Group I (n = 80)	Group II (n = 45)	Group III (n = 13)	Group IV (n = 17)
Clinical Characteristics	Post-AMI patients with any degree of LV dysfunction	Patients with non-ischemic heart disease and LV dysfunction (EF < 40%)	Patients with ARVD	Patients with “channelopathies”
Structural Heart Disease	Post-AMI (CAD)	Chagas heart disease (n = 18) Idiopathic dilated cardiomyopathy (n = 12) Hypertensive disease (n = 8) Hypertrophic cardiomyopathy (n = 4) Valvular heart disease (n = 3)	ARVD	Brugada syndrome (n = 8) Idiopathic ventricular fibrillation (n = 5) Idiopathic ventricular tachycardia (n = 4)

Table 1 - Group of patients who underwent ICD implantation, according to their clinical characteristics and structural heart diseases. *(ARVD) = Arrhythmogenic right ventricular dysplasia.

Clinical and Electrophysiological Characteristics of the Patients	Group I (n = 80)	Group II (n = 45)	Groups III and IV (n = 30)
Gender			
Male	9	19	8
Female	71 (89%)	26 (58%)	22 (73%)
Mean Age (years)	60 (27-88)	44 (22-53)	37 (28-44)
EF function			
EF < 20%	26 (32.5%)	24 (53%)	0
EF 20-30%	50 (62.5%)	16 (36%)	0
EF 30-40%	4 (5%)	5 (11%)	2 (7%)
Normal EF	0	0	28 (93%)
Initial clinical presentation			
SMVT	57 (71%)	17 (38%)	11 (37%)
Resuscitated sudden death	6 (4%)	7 (15%)	7 (23%)
Syncope/Presyncope	14 (17.5%)	19 (42%)	11 (37%)
NSVT	3 (7.5%)	2 (5%)	1 (3%)
EPS			
SMVT	70 (87.5%)	32 (71%)	12 (40%)
Poly VT/VF	10	13	15 (50%)
Normal	0	0	3
Use of antiarrhythmic drugs (% of patients)			
Amiodarone	95%	90%	39%
Sotalol	5%	10%	35%
None			26%
Follow-up > 1 year (% of patients)	85%	90%	95%

EF- ejection fraction; SMVT - sustained monomorphic ventricular; NSVT - nonsustained ventricular tachycardia; VT - ventricular tachycardia; VF - ventricular fibrillation

Table 2 - Clinical and electrophysiological characteristics of the four groups of heart-disease patients.

chamber ICDs were used and, later on, dual-chamber ICDs. According to the standard technique for endocardial pacemaker implantation using fluoroscopy, once the left subclavian vein was punctured two bipolar endocardial leads, in the case of dual-chamber pacemaker, were implanted. Subsequently, antibradycardia functions were measured perioperatively: stimulation thresholds in the atrium and ventricle, P-wave and QRS complex amplitudes, and impedance. As for antitachycardia functions, a single one-joule shock was delivered to the cardioverter or defibrillator lead to check system impedance and VF was induced using the protocol for shock on the T-wave to determine the defibrillation threshold.

ICD programming was not consistent, because of the large number of patients analyzed. Overall, stimulation frequency was programmed at 50-60 bpm for the bradycardia zone, with three tachycardia detection zones (Zone 1 – heart rate between 140 and 160 bpm; Zone 2- heart rate between 160 and 180 bpm, and Zone 3 – heart rate above 180 bpm). In zone 3, the shock therapy function was routinely activated (cardioversion or defibrillation). Shock energy was programmed according to the defibrillation threshold of the surgery.

Postoperatively, patients stayed in hospital for 24 to 48

hours on the same antiarrhythmic drugs they were taking before implantation. After dismissal, patients were evaluated at 7, 15 and 30-day intervals. After the first month, ICD discharges were evaluated every three months, together with overall and arrhythmic mortality. At every outpatient visit, in addition to a thorough clinical examination, the following questions were raised regarding the devices: a) occurrence of appropriate and inappropriate discharges; b) atrial (DDD mode) and ventricular stimulation thresholds; c) R-wave and P-wave measurements; d) shock impedance.

Antitachycardia pacing therapy (ATP) and shocks triggered were considered

ICD discharge, as evidenced in the interviews during the outpatient visits.

Statistical analysis - Comparisons were made using the Student's t test for continuous variables and the Mann-Whitney for the means among the three groups (patients with and without shocks considered). **P ≤ 0.05 was considered statistically significant.** Survival analysis was based on nonparametric Kaplan-Meir estimates and Cox regression models.

Results

Patients' general characteristics - In the four groups, there was a male predominance (77%) among patients undergoing ICD implantation (Tab. 2).

Most patients in groups I and II had major impairment of left ventricular function. After ICD implantation, use of antiarrhythmic drugs was encouraged in order to reduce incidence of inappropriate discharges. In groups I and II, 95% and 90% of the patients, respectively, were using amiodarone before ICD implantation. In group III, 60% of the patients were using amiodarone, and 35%, sotalol.

Profile of appropriate ICD discharges - At a mean follow-up of 26 months, a high rate of patients experienced appropriate ICD discharges (antitachycardia pacing and/or shock therapy) in the four groups of heart disease patients (Figure 1), with a mean value of 46%. There was no statistically significant difference in the percentage of patients who had appropriate ICD discharges in the four groups.

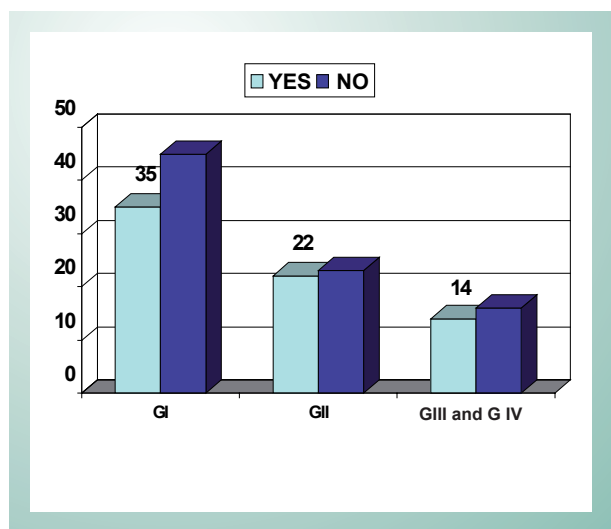


Fig 1 - Appropriate ICD discharges (% of patients) in the four groups show very similar discharge rates.

Group I - Thirty-five of the 80 (44%) patients with previous myocardial infarction and ventricular dysfunction who underwent ICD implantation had appropriate discharges at some point during the clinical follow-up (Figure 1). Patients with and without appropriate ICD discharges did not differ in age, gender, and left ventricular function (Tab. 3). Mortality rate was not higher among patients with and without appropriate ICD discharges ($p = 0.18$). Amiodarone was the antiarrhythmic drug used in 95% of the patients with and without discharges. The antiarrhythmic drug was maintained after implantation in an attempt to reduce appropriate ICD discharges and/or prevent the first shock from occurring.

Initial clinical presentation and inducible ventricular arrhythmia at the electrophysiological study did not serve as markers to identify patients who did or did not experienced appropriate ICD discharges.

Group II - Forty-eight percent of the patients had some kind of appropriate ICD therapy during clinical follow-up.

When compared and analyzed separately, Group II heart diseases did not differ significantly in terms of appropriate ICD discharges (Figure 2).

Chronic Chagas heart disease - During a mean follow-up of 39.7 months (8-72 months), ICD discharges of 18 patients with chronic Chagas heart disease (12 female and 6 male), mean age 37.3 (15-54 years), were evaluated. As with the post-AMI group (Group I), chagasic patients with and without ICD discharges did not differ in age, gender, and left ventricular function. Initial clinical presentation and inducible ventricular arrhythmia at EPS, as well as the use of antiarrhythmic drugs before and after implantation, did not influence the appropriate ICD discharge pattern. Only 1 of 18 of the chagasic patients had inappropriate ICD discharges. The retrospective analysis of intracavitary electrograms was suggestive of supraventricular tachycardia.

There were four deaths during follow-up of from 1 to 2,920 days postimplantation. The five-year survival rate was 80%. Two-fourths of those who died belonged to the group with discharges. Three deaths were cardiac (congestive heart failure) and one was noncardiac (bacterial pneumonia and sepsis). A Kaplan-Meier curve depicting survival probability is shown in Figure 3. Five of 18 (27%) chagasic patients treated with ICD implantation showed the additional finding of sinus dysfunction at EPS.

Group III - Arrhythmogenic right ventricular dysplasia - Thirteen ARVD patients were analyzed (Tab. 4). The diagnosis of arrhythmogenic right ventricular dysplasia was based on the clinical, pathoanatomical, and electrocardiographic criteria proposed by the European Society of Cardiology¹⁸.

In a mean follow-up of 51 months (30 to 67 months), 8 of 13 the patients with arrhythmogenic RV dysplasia had appropriate ICD discharges. Of these, 90% were experienced in the first 12 months after ICD implantation, with a significant decrease in discharges over the years. Patients with and without appropriate ICD discharges did not differ in age, gender, left ventricular function, follow-up time, use of antiarrhythmic drugs, overall mortality and profile of inappropriate ICD discharges. Other arrhythmias detected during the EPS of these patients included sustained atrial arrhythmias, such as atrial flutter and fibrillation, found in two and one patient, respectively.

Of the 13 patients, four (31%) had inappropriate ICD discharges, one patient for sinus tachycardia, two for supraventricular tachyarrhythmia, and one patient while dealing with electricity. No inappropriate discharges due to T-wave oversensing was found.

There were no complications directly related to the ICD implantation nor any record of right ventricle perforation during the ventricular lead placement.

Group IV - Channelopathies - Brugada Syndrome: Three of the eight patients (33%) with Brugada syndrome had appropriate ICD therapies. Three patients (37%) had inappropriate ICD discharges. The retrospective analysis of intracavitary electrograms suggested that in one patient these discharges were secondary to sinus tachycardia episodes. In the other two they had been triggered by supraentricular tachycardias.

	Therapies + (n = 35)	Therapies - (n = 45)	p value
Male	25 (88%)	34 (77%)	NS
Deaths	5 (14%)	3 (7%)	NS
LV dysfunction			
EF 25%-40%	22 (64%)	36 (81%)	NS
EF <25%	12 (36%)	9 (19%)	NS
Clinical SMVT	22 (64%)	26 (58%)	NS
EPS with SMVT	31 (88%)	42 (93%)	NS
Nº of ES	Dual-site RV pacing (48%)	Dual-site RV pacing (65%)	NS
Follow-up > 1 year	33 (96%)	33 (77%)	NS
Amiodarone use	100%	95%	NS

EF- Left ventricular ejection fraction (LV); SMVT- sustained monomorphic ventricular tachycardia; EPS- electricalphysiological study; Nº. of ES = number of right ventricle (RV) extrastimuli to induce a sustained ventricular arrhythmia. Initial clinical presentation and inducible ventricular arrhythmia at the electrophysiological study did not serve as markers to identify patients who did or did not experienced appropriate ICD discharges.

Table 3 - Clinical and electrophysiological characteristics of patients with (therapies +) and without (therapies -) appropriate ICD therapies in Group I (post-AMI patients).

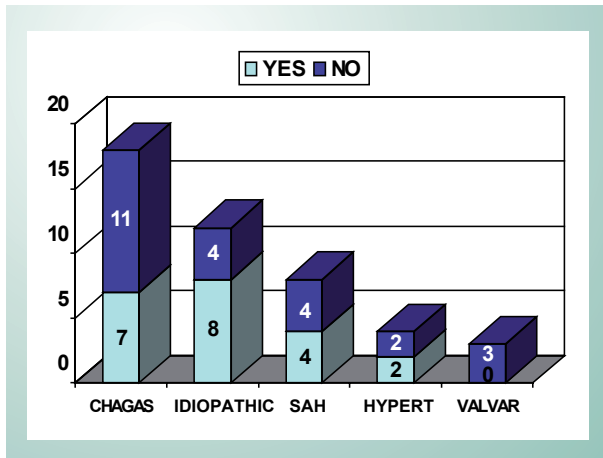


Fig. 2 - Appropriate ICD discharges (including antitachycardia pacing and shock therapies) in group II.

Idiopathic ventricular arrhythmias - No patient with idiopathic ventricular fibrillation had ICD discharges, whereas all patients with idiopathic ventricular tachycardia had some ICD discharge during clinical follow-up.

Inappropriate discharges - In the four groups analyzed, 9.7% had inappropriate ICD therapies at some point of the clinical follow-up. Forty-seven percent of all inappropriate discharges were found in Groups III and IV. Patients with ARVD and Brugada syndrome accounted for the greatest number of inappropriate ICD therapies. A great part of these therapies were triggered by supraventricular tachyarrhythmias. After these arrhythmias were successfully ablated, inappropriate ICD therapies were no longer documented.

Statistically, patients in groups III and IV showed higher rates of inappropriate discharges, when compared with those of the other two groups. Comparing Groups I and Group II, we had a p value of 0.02; in the comparative analysis of Groups

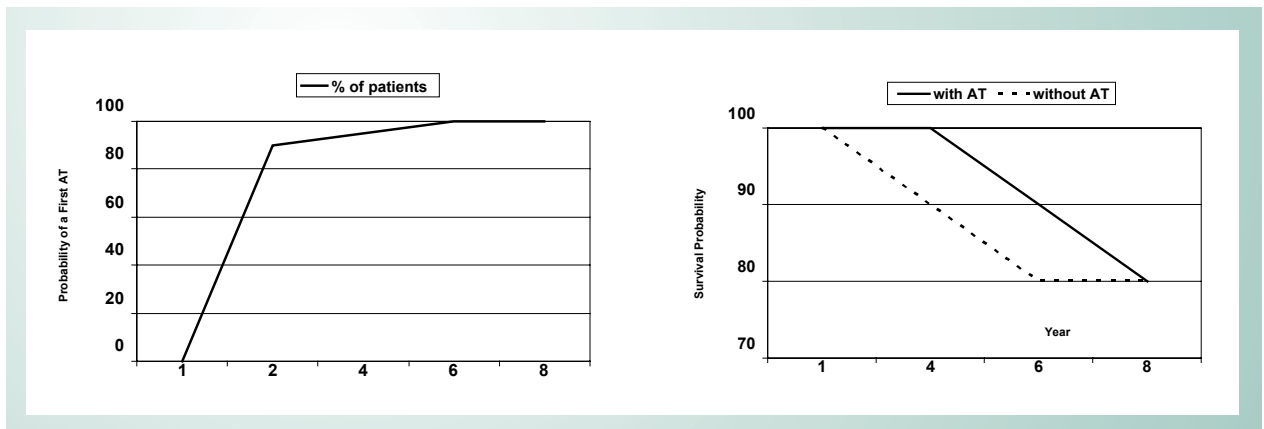


Fig. 3 - Kaplan-Meier probability of chagasic patients having a first appropriate ICD therapy (AT) and survival probability in chagasic patients with and without appropriate ICD therapies.

Patients/clinical characteristics	Gender	Age (years)	Mean follow-up (months)	Ejection fraction (EF)	Initial clinical presentation
Patient 1	M	25	31	Normal	Syncope
Patient 2	M	38	39	Normal	Syncope
Patient 3	M	49	53	30-40%	NSVT
Patient 4	M	44	30	30-40%	SMVT
Patient 5	F	52	51	Normal	SMVT
Patient 6	M	54	47	Normal	Sudden death
Patient 7	M	50	67	Normal	SMVT
Patient 8	M	35	62	Normal	SMVT
Patient 9	M	45	70	Normal	SMVT
Patient 10	F	34	48	Normal	Syncope
Patient 11	M	40	65	Normal	SMVT
Patient 12	M	15	47	Normal	SMVT
Patient 13	M	22	50	Normal	SMVT

SMVT- Sustained monomorphic ventricular tachycardia; NSVT- nonsustained ventricular tachycardia; Syncope- Unexplained syncope or presyncope, Sudden death- patients resuscitated from sudden death. M: male; F: female.

Table 4 – Clinical features of arrhythmogenic right ventricular dysplasia (ARVD).

II and III this value was 0.035. Groups I and II did not differ in terms of inappropriate ICD therapies.

Overall and arrhythmic mortality - There were 14 deaths (11.2% from overall mortality) in the clinical outpatient follow up of the 155 patients. Of these, eight belonged to Group I (10% of the 80 patients analyzed), four belonged to group II (8.8% of the 45 patients analyzed), and 2 belonged to Groups III and IV (6.6% of the 30 patients analyzed), as shown in Table 5. Comparatively, mortality rates in the four groups of heart disease were similar.

Procedure-related complications - Two early procedure-related complications occurred. Two patients died during implantation. Two of the 155 patients experienced late generator pocket infection, requiring pulse-generator explantation and antibiotic therapy. Both patients evolved satisfactorily and had their ICD reimplemented after the infection had resolved. One patient experienced infective endocarditis, diagnosed by the presence of vegetation on the ventricular lead.

Discussion

The primary purpose of this study is to describe the

outpatient clinical follow-up of patients with a wide range of heart diseases that underwent ICD implantation in two reference centers for the treatment of cardiac arrhythmias in Rio de Janeiro.

Theoretically, evaluating a higher or lower incidence of ICD discharges in each group of patients, the individual benefit of this therapeutic strategy in preventing sudden death in the outpatient setting could be inferred. Yet, this is not entirely true, because several shocks and/or antitachycardia pacing may treat arrhythmic episodes that would resolve spontaneously and not necessarily evolve to death^{19,20}.

Given the absence of a control group using antiarrhythmic drugs, overall and arrhythmic mortality analysis was compromised. The attempt to correlate ICD discharge greater occurrence with a worse prognosis was a valid alternative to gain insight into the benefit of ICD in different heart diseases.

Based on the fact that appropriate ICD therapies prevent death, one may conclude that at least half of the patients stratified as at high risk by history and clinical presentation associated with an EPS would be dead had they not undergone ICD implantation.

	Group I (n = 80)	Group II (n = 45)	Group III (n = 30)	Group IV (n = 155)
Cardiac Cause	5 (6.25%)	2 (4.4%)	1 (3.3%)	8 (4.5%)
Noncardiac Cause	2 (2.5%)	1 (2.2%)	1 (3.3%)	4 (2.6%)
Sudden Death	1 (1.25%)	1 (2.2%)	0	2 (1.3%)
Total	8 (10%)	4 (8.8%)	2 (6.6%)	14 (8.4%)

Table 5 - Overall and specific mortality in the four groups of heart disease

No patient underwent ICD implantation without prior EPS with induction of sustained ventricular arrhythmia (except three very specific cases, which were not included in this analysis).

Until completion of this study, randomized clinical trials failed to demonstrate the utility of these devices in preventing sudden death in the group of non-ischemic patients⁴⁴. Despite not constituting the majority of patients analyzed, the group of patients with Chagas disease provided the most practical information for this study. Half of the chagasic patients who underwent ICD implantation had appropriate ICD discharges. As previously noted, these patients were already at a higher arrhythmic risk, considering their degree of ventricular function involvement. Even under amiodarone, they underwent EPS and, in case of inducible ventricular arrhythmia, ICD implantation was performed. Chagasic patients have proved to be at high risk of sudden death, considering the high rates of appropriate therapies observed²¹⁻²³.

Patients with post-AMI ischemic heart disease formed the largest group of patients analyzed. It should be noted that these patients had already been stratified by clinical history and ventricular function^{13,24} as at higher risk, and that they also benefited, like the chagasic patients, from the ICD implantation.

In patients with unexplained syncope or NSVT on 24-hour Holter, that represented a small number of our sample, ICD implantation was performed as primary prophylaxis. These patients did not show a very aggressive pattern of ICD discharge and, at first, seemed not to benefit from ICD implantation to the same extent as the others, but since they were a minority even in the ischemic group, it would be premature to conclude that this strategy is not beneficial for this group of patients, since the opposite was recently well documented in the literature^{25,26}.

The most aggressive pattern of appropriate ICD discharges (that is, the highest number of appropriate therapy per patient) was found in the group of patients with arrhythmogenic right ventricular dysplasia. This information has confirmed the clinical impression that, in fact, this group of patients, after

invasive and noninvasive risk stratification, would not benefit from the use of antiarrhythmic medication alone and that ICD is mandatory in selected patients^{7,11,13,14}.

A significant rate of inappropriate therapies was observed in nonischemic patients without structural heart disease. The number of inappropriate discharges in patients of Groups III and IV was statistically significantly higher, reflecting a greater incidence of supraventricular arrhythmias in these younger patients without significant left ventricular dysfunction, as evidenced in the literature²⁷.

Apparently, the acute and chronic values of the R-wave did not influence the occurrence of inappropriate therapies.

With regard to the ICD role in reducing mortality, the rate of sudden cardiac death was found to be low in the study sample: 1.25% in patients with ischemic heart disease, 2.2% in patients with Chagas disease, and 0% in the group of patients with nonischemic heart disease without involvement of the left ventricular function. In the present analysis, cardiac etiology, notably progression of heart failure, accounted for the greater number of deaths in groups I and II, as it has been reported by other authors²⁴.

No independent clinical or electrophysiological predictor capable of identifying ischemic and nonischemic patients at higher risk of having ICD appropriate discharge was found, unlike what was observed in case reports or small observational studies²⁸⁻³¹. There was a low rate of early and late procedure-related complications, comparable to those found in other centers throughout the world³².

Conclusion

This is the first Brazilian study to analyze the impact of ICD in the outcome of patients with different underlying heart diseases and degrees of ventricular dysfunction at high risk of sudden death. The high rate of appropriate ICD therapy and low number of sudden deaths in this ICD-implanted population validate the risk stratification strategy for sudden death employed.

References

1. Myerburg RJ, Castellanos A. Cardiac arrest and sudden cardiac death. In: Braunwald E. Heart Disease: a textbook of cardiovascular medicine. 4th ed. Philadelphia: WB Saunders; 1992. p. 756-789.
2. Myerburg RJ, Kessler KM, Castellanos A. Sudden cardiac death: epidemiology, transient risk, and intervention assessment. *Ann Intern Med.* 1993;119: 1187-97.
3. Myerburg RJ, Interian A Jr, Mitrani A. Frequency of sudden cardiac death and profiles of risk. *Am J Cardiol.* 1997; 80:10-9.
4. Zipes DP, Wellens HJJ. Sudden cardiac death. *Circulation.* 1998; 98: 2334-51.
5. Heikki VH, Agustin C, Robert JM. Sudden death due to cardiac arrhythmias. *N Engl J Med.* 2001; 345: 1473-82.
6. Mark J, Hein JJW. Implantable defibrillators and sudden cardiac death. *Circulation.* 2004; 109: 2685-91.
7. Priori SG, Aliot E, Blomstrom-Lundqvist C. Task force on sudden cardiac death of the European Society of Cardiology. *Eur Heart J.* 2001; 22: 1374-9.
8. Pratt CM, Moye LA. Effect of the antiarrhythmic agent moricizine on survival after myocardial infarction. *N Engl J Med.* 1992; 327: 227-33.
9. Greenberg HM, Dwyer EM, Hochman JS. Interaction of ischemia and encainide/flecainide treatment: a proposed mechanism for the increased mortality in CAST I. *Br Heart J.* 1995; 74: 631-55.
10. Guiraudon G, Fontaine G, Frank R. Encircling endocardial ventriculotomy: a new surgical treatment for life-threatening ventricular tachycardias resistant to medical treatment following myocardial infarction. *Ann Thorac. Surg.* 1978; 26: 438-44.
11. Mirowski M, Reid PR, Mower MM. Termination of malignant ventricular arrhythmias with an implanted automatic defibrillator in human beings. *N Engl J Med.* 1980; 303: 322-4.
12. Connolly SJ, Hallstrom AP, Cappato R. Meta-analysis of the implantable

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- cardioverter defibrillator secondary prevention trials. AVID, CASH and CIDS studies. Antiarrhythmics vs Implantable Defibrillator study. Cardiac Arrest Study Hamburg. Canadian Implantable Defibrillator Study. *Eur Heart J*. 2000; 21: 2071-5.
13. Buxton AE, Lee KL, Fisher JD, Josephson ME, Prystowsky EN, Hafley G. A randomized study of the prevention of sudden death in patients with coronary artery disease. *N Engl J Med*. 1999; 341:1882-90.
 14. Kuck KH, Cappato R, Siebels J, Ruppel R. Randomized comparison of antiarrhythmic drug therapy with implantable defibrillators in patients resuscitated from cardiac arrest. The Cardiac Arrest Study Hamburg (CASH). *Circulation*. 2000; 102: 748-54.
 15. Gregoratos G, Abrams J, Epstein AE. ACC/AHA/NASPE 2002 Guideline update for implantation of cardiac pacemakers and antiarrhythmia devices: summary article. *Circulation*. 2002; 106: 2145-56.
 16. Bhandari AK, Rahimtoola SH, Wu D. Frequency and significance of induced sustained ventricular tachycardia or fibrillation 2 weeks after acute myocardial infarction. *Am J Cardiol*. 1985; 56: 737-42.
 17. Iesaka Y, Nogami A, Aonuma K, Nitta J, Chun YH, Fujiwara H, et al. Prognostic significance of sustained monomorphic ventricular tachycardia induced by programmed ventricular stimulation using up to triple extrastimuli in survivors of acute myocardial infarction. *Am J Cardiol*. 1990; 65: 1057-63.
 18. McKenna WJ, Thiene G, Nava A. Diagnosis of arrhythmogenic right ventricular dysplasia/cardiomyopathy. *Br Heart J*. 1994; 71: 215-8.
 19. Teerlink JR, Jalaluddin M, Anderson S. Ambulatory ventricular arrhythmias in patients with heart failure do not specifically predict an increased risk of sudden death. *Circulation*. 2000; 101: 40-6.
 20. Pacifico A, Ferlic LL, Cedillo-Salazar FR, Nasir N Jr, Doyle TK, Henry PD. Shocks as predictors of survival in patients with implantable cardioverter-defibrillators. *J Am Coll Cardiol*. 1999; 34: 204-10.
 21. Cruz FE, Maia IG. Arritmias cardíacas na miocardiopatia chagásica. In: Cruz F (org.). *Eletrofisiologia clínica e intervencionista das arritmias cardíacas*. Rio de Janeiro: Revinter, 1997. p. 197-216.
 22. Martinelli Filho M, De Siqueira SF, Moreira H, Fagundes A, Pedrosa A, Nishioka SD, et al. Probability of occurrence of life threatening ventricular arrhythmias in Chagas' disease versus non-Chagas' disease. *Pacing Clin Electrophysiol*. 2000; 23: 1944-6.
 23. Fonarow GC, Feliciano Z, Boyle NG. Improved survival in patients with non ischemic advanced heart failure and syncope treated with an implantable cardioverter-defibrillator. *Am J Cardiol*. 2000; 85: 981-5.
 24. Domanski MJ, Sakseena S, Epstein AE. Relative effectiveness of the implantable cardioverter-defibrillator and antiarrhythmic drugs in patients with varying degrees of left ventricular dysfunction who have survived malignant ventricular arrhythmias. *J Am Coll Cardiol*. 1999; 34: 1090-4.
 25. Wever EFD, Hauer RNW, Schrijvers G. Cost-effectiveness of implantable defibrillator as first-choice therapy versus electrophysiologically guided, tiered strategy for postinfarct sudden death survivors: a randomized study. *Circulation*. 1996; 93: 489-96.
 26. Tada H, Ohe T, Yutani C. Sudden death in a patient with apparent idiopathic ventricular tachycardia. *Jpn Circ J*. 1996; 60: 133-6.
 27. Marcus FL. Update of arrhythmogenic right ventricular dysplasia. *Card Electrophysiol Rev*. 2002; 6: 54-6.
 28. Hallstrom AP, McAnulty JH, Wilkoff BL. Patients at lower risk of arrhythmia recurrence: a subgroup in whom implantable defibrillators may not offer benefit. Antiarrhythmics Versus Implantable Defibrillator (AVID) Trial Investigators. *J Am Coll Cardiol*. 2001; 37:1093-9.
 29. Kim SG, Hallstrom A, Love JC. Comparison of clinical characteristics and frequency of implantable defibrillator use between randomized patients in the Antiarrhythmics Vs Implantable Defibrillator (AVID) Trial and non randomized registry patients. *Am J Cardiol*. 1997; 80: 454-7.
 30. Anthony CC, Frank IM, Elizabeth AH. Predictors of arrhythmic death and cardiac arrest in the ESVEM trial. *Circulation*. 1997; 96: 1888-92.
 31. Rankovic V, Karha J, Passman R, Kadish AH, Goldberger JJ. Predictors of appropriate implantable cardioverterdefibrillator therapy in patients with idiopathic dilated cardiomyopathy. *Am J Cardiol*. 2002; 89: 1072-6.
 32. Rosenqvist M, Beyer T, Block M, den Dulk K, Minten J, Lindemans F. Adverse events with transvenous implantable cardioverter-defibrillators: a Prospective Multicenter Study. *Circulation*. 1998; 98: 663-70.