

Original Article

Under-Utilization of Implantable Cardioverter Defibrillators in Patients with Heart Failure - The Current State of Sudden Cardiac Death Prophylaxis

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Abstract

Background: Despite ACC/AHA guidelines indicating implantable cardioverter defibrillator (ICD) as class I therapy for primary prevention of sudden cardiac death in patients with $EF \leq 35\%$, ICD utilization rates in real world practice have been low.

Objective: To determine the rate of ICD implantation at a tertiary care academic center and to assess the reasons for under-utilization of the same.

Methods: Review of a prospectively collected database which included all patients diagnosed with an $EF \leq 35\%$ was performed to assess the rate of ICD implantation and mortality. Reasons for non-implantation of ICD were then assessed from detailed chart review.

Results: A total of 707 patients (age 69.4 ± 14.1 years) with mean EF of $26 \pm 7\%$ were analyzed. Only 28% (200/707) of patients had ICDs implanted. Mortality was lower in the group with ICD (25% vs 37%, $p=0.004$). When patients who either died or were lost to follow-up prior to 2005 were excluded, ICD utilization rate was still low at 37.6%. The most common reason for non-implantation of ICD was physicians not discussing this option with their patients. Patient refusal was the second most common reason.

Conclusions: ICD Implantation rates for primary prevention of SCD in patients with $EF \leq 35\%$ is low. Physician and patient education should be addressed to improve the utilization rates.

Key words: Implantable cardioverter-defibrillator, Outcomes, sudden cardiac death

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Background

Heart Failure is a major public health problem affecting more than 5 million people in the United States with 550,000 new cases diagnosed annually and 57,000 deaths annually [1,2]. Mortality rates from the Framingham population study are over 25% at 1 year and 50% at 5 years after the onset of heart failure [2]. The two main causes of death in patients with heart failure are progressive heart failure and sudden cardiac death (SCD).

Consequently, the 2005 ACC/AHA/ECS heart failure guidelines and the 2009 update recommend optimum medical management with beta-blockers (BB), angiotensin-converting enzyme inhibitors (ACE) or angiotensin receptor blockers (ARB), and aldosterone antagonists (AA) as Class I therapies to prevent progression of HF and to improve survival. These guidelines also recommend an implantable cardioverter defibrillator (ICD) as a Class I indication for the primary prevention of sudden cardiac death (SCD) in patients with ischemic and non-ischemic cardiomyopathy with an EF < 35% with NYHA class II and III (Class IIa for EF between 30-35% per 2005 guidelines which is now a class I indication) [3,4]. These guidelines are based on several randomized control trials including MADIT- I and II, MUSTT and SCDHeFT [5-8].

While these randomized clinical trials have shown survival benefit of ICD's in patients with left ventricular systolic dysfunction, the utilization rate of ICD's for primary prevention of SCD in real world practice has remained suboptimal and varies greatly from less than 20% to 40% [9-12]. Only a small number of hospitals across the United States have ICD implantation rates above 50% for eligible patients [9]. While gender and racial disparities and hospital level variations have been described, the reasons for underutilization of ICD's from a clinical stand point are largely unknown. In this study we report the rates of ICD implantation and medical management in patients with left ventricular systolic dysfunction with EF \leq 35% at a large academic medical center and evaluate the reasons for underutilization.

Methods

This is a retrospective study of a large observational study derived from a prospectively collected Cardiovascular Database at the University of Kansas Hospital, Kansas City, KS. This is a tertiary care referral center for the Midwestern region with a large cardiovascular program including state of the art electrophysiology laboratories and five electrophysiologists.

Study population

The study population included all patients who were diagnosed with left ventricular ejection fraction (LVEF) \leq 35% between 1998 and 2006. A low EF documented by any of the imaging modalities including echocardiogram, nuclear imaging, cardiac computer tomographic angiography or magnetic resonance imaging or ventriculography were considered appropriate for the study. Cardiovascular database, electronic medical records and paper charts of these patients were reviewed by two investigators after obtaining approval from the institutional review board. The conduct of the study was overseen within the regulatory guidelines of HIPAA. Three consecutive EFs were extracted for each patient. If there was a sudden change in EFs in a 6 month period, accuracy of EFs were evaluated by reviewing the actual imaging study. The oldest LVEF \leq 35% was included in the study analysis. Each patient was followed until May 2009. Patients who spontaneously improved their EF within 1 year were excluded from the study. Patients who had an improvement in EF beyond 1 year were also noted. For analysis of mortality, all patients were included but for purposes of ICD implantation analysis, all patients who died or were lost to follow-up prior to and including year 2005 were excluded. This is because guidelines reporting implantation of

ICDs for primary prevention in ischemic and non-ischemic patients with EF<35% was reported only in 2005 after the SCD-Heft trial. Prior to that, ICDs were indicated only in ischemic cardiomyopathy patients with EF< 30% per the 2002 device therapy guidelines as a class IIa recommendation. Baseline demographic variables and clinical variables along with medical treatment received with BBs, ACEIs, ARBs, AA and ICDs were also noted. Time to ICD implantation was considered from the earliest date when EF \leq 35 % was recorded. Mortality records were obtained from social security death index.

Assessing reasons for non implantation of ICDs

Records were manually reviewed by 2 independent investigators to identify the reasons why an ICD was not implanted. All patients who had an EF \leq 35% for at least one year from the initial diagnosis of LV dysfunction and were still alive and following with the clinics were assessed for reasons why an ICD was not implanted. All cardiology clinic encounters were reviewed and any mention of ICD implantation by the cardiologist was considered as discussed. If there was no documentation about ICD in any of the encounters, it was considered that the cardiologist had not discussed it. However, if specific reasons such as significant comorbidities or patient refusal were cited for non-implantation of ICDs they were accordingly noted. Patients who had a single or dual chamber pacemaker but no ICD were also reviewed for documentation of a discussion regarding ICD upgrade.

Statistical analysis

Rates of ICD implantation and medical treatment received were expressed as percentages while continuous data was expressed as mean \pm SD. Student t tests were used to compare continuous variables while Chi-square and Exact tests were used to compare discrete variables. A p value less than 0.05 was considered significant. Kaplan-Meier survival curves were obtained for patients with and without ICD implantation. Cox proportional hazards model with forward model was used to identify univariate and multivariate predictors of mortality. Logistic regression analysis was used to identify predictors of ICD implantation. Reasons for ICD non-utilization were all analyzed after excluding patients who died or were lost to follow up prior to 2005 and noted in percentages. SAS version 9.1.3 (SAS Institute Inc, Cary, NC) was used for the analyses.

Results

A total of 707 patients (age 69.4 ± 14.1 years) with an EF \leq 35% met inclusion criteria. Echocardiogram was the most common method utilized for EF measurement (84% patients) followed by thallium stress test, ventriculogram and multigated nuclear scan (MUGA). Mean EF was $26 \pm 7\%$. NYHA (New York Heart Association) class 1, 2, 3 and 4 were seen in 30%, 40%, 26% and 4% of patients respectively. Mean QRS duration was 125 ± 36 ms. The majority of patients were males (66%) and of Caucasian race (80%). Ischemic cardiomyopathy was seen in 59% of patients while 41% had non-ischemic cardiomyopathy. Mean duration of cardiomyopathy (LV dysfunction) was 76 ± 21 months. Percentages of patients on ASA, BB and ACE/ARB were 80%, 81% and 75% respectively at 1 year of heart failure diagnosis. AA, digoxin and statins were used in 24%, 50% and 68% of patients respectively. Eighty percent were on diuretics. ICDs were implanted in only 28% of patients (n = 200/707). There was a significant difference in all cause mortality between HF patients with ICDs compared to those without (25% vs 37%, p=0.004). **Figure 1** shows Kaplan-Meier survival curves for patients with and without ICD. Age (HR 1.02, CI 1.01-1.03 p<0.0001), absence of ICD (HR 1.5, CI 1.1-2, p=0.04), lower EF (HR 3.4, CI 1.6-10, p=0.04), and NYHA class (HR 1.7, CI 1.2-2.3, p=0.001) were found to be significant predictors of mortality on multivariate analysis.

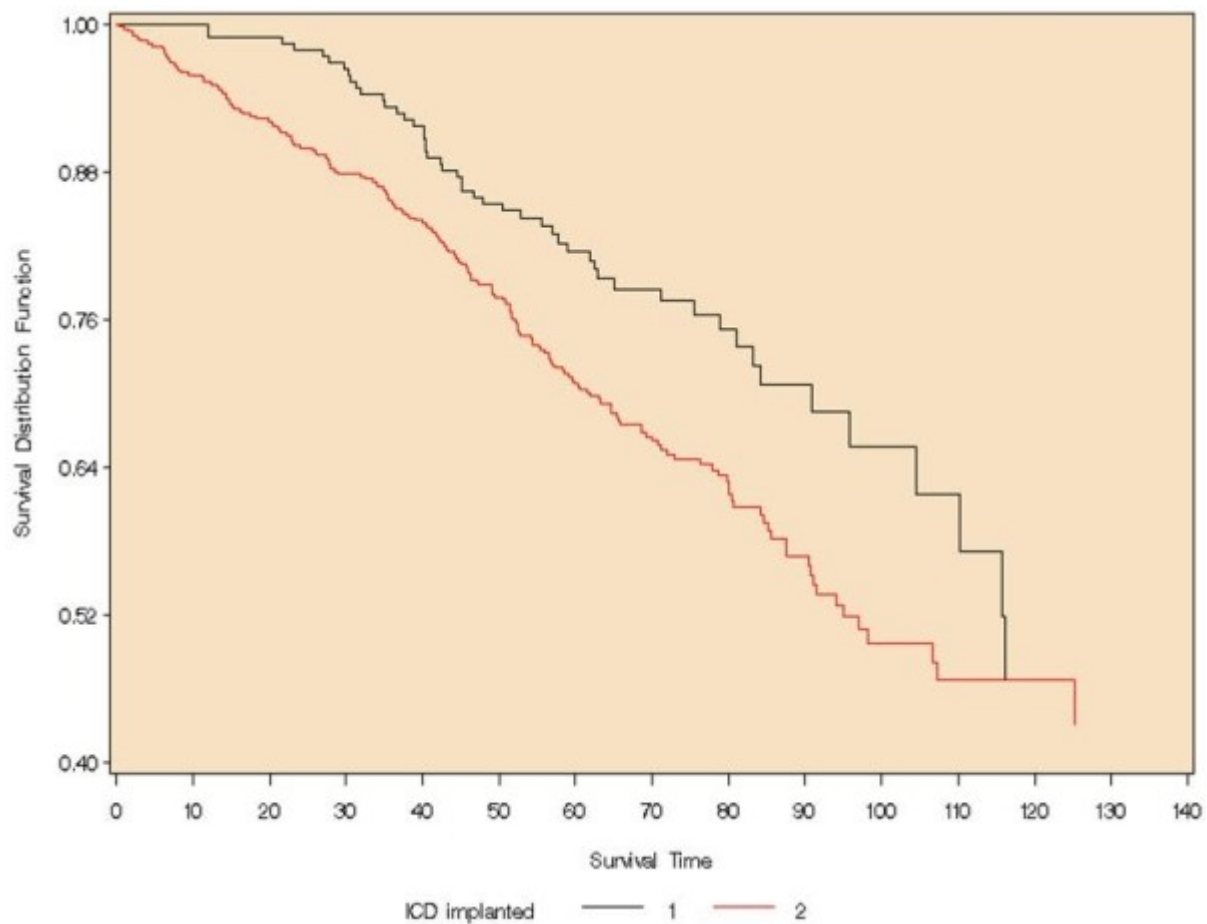


Figure 1: Kaplan Meir Survival Curves (in months) for Patients with ICD (1) and Without ICD (2).

Since the guidelines recommended ICD therapy for primary prevention for patients with ischemic and non ischemic cardiomyopathy with EF<35% only in 2005, for purposes of ICD implantation assessment, all patients who died prior to December 2005 (n=72 with 64 in non-ICD group and 8 in ICD group) and patients who were lost to follow-up prior to December 2005 (n=125) were excluded. The effective sample size was thus 510 patients.

The ACC/AHA 2002 guidelines do indicate ICD implantation in patients with ischemic cardiomyopathy with EF <30% as class IIa indication. Accordingly, of the 64 patients who died prior to 2005 in the no-ICD group, 36% of them qualified for ICD implantation. A considerable proportion of patients (n=125) were lost to follow-up as the University hospital is a tertiary referral center and patients were admitted for procedures and acute events with follow up in clinics once or twice and were then lost to follow-up.

Of the 510 patients who were alive after 2005, the percentage of patients with an ICD was 37.6% (192/510). Baseline demographic and clinical characteristics of these patients with and without an ICD are represented in **Table 1**. In patients who had an ICD implanted, mean duration between diagnosis and implantation was 2.9 ± 2.1 years. These patients had higher body mass index, longer QRS interval and were on optimal medical management (BB, ACE/ARB, AA and statins) compared to those without an ICD. Univariate predictors of ICD implantation included presence of BB, ACE/ARB, diuretic, AA, statins and higher QRS. On multivariate analysis, presence of ACE inhibitors/ARB (OR 2, CI 1.2-3.4, p=0.04) and AA (OR 1.9, CI 1.3-3, p=0.001) were found to be the only predictors of ICD implantation. Of those patients who had an ICD, 48% of patients had cardiac resynchronization therapy-defibrillator (CRT-D), 31% of patients had a dual chamber ICD while 21% had a single chamber ICD. Patients without an ICD had pacemakers in 19.7% including CRT-pacemaker in 3%

Table 1: Baseline demographic and clinical variables.

Variable	ICD (n=192)	No ICD (n=318)	P value
Age (years)	68.1 ± 12.1	70 ± 14.8	0.1
males (%)	70.8	65.4	0.2
caucasian (%)	82	79	0.6
Ischemic Cardiomyopathy (%)	63	59	0.15
BMI (kg/m ²)	29.2 ± 7.8	28 ± 6.0	0.05
QRS duration (ms)	131 ± 36	124 ± 37	0.05
NYHA class 4	2	1.5	0.7
Ejection fraction (%)	29±7	28±7	0.06
Aspirin (%)	86	81	0.1
BB (%)	91	81	0.007
ACE/ ARB (%)	85	74	0.002
Aldosterone antagonist (%)	33.6	20.8	0.0006
Digoxin (%)	58	48	0.07
Statin (%)	79	70	0.02
Diuretic (%)	87	80	0.03
Diabetes Mellitus (%)	30	24	0.15
Hypertension (%)	52	52	0.4
Coronary artery disease (%)	59	52	0.1
Peripheral artery disease (%)	4	6	0.3
Stroke (%)	4	6	0.4
Dementia (%)	0.5	0.6	0.4
Dyslipidemia (%)	58	50	0.6
CABG (%)	3.7	3.8	0.4
Atrial fibrillation (%)	30	23	0.08
COPD (%)	11	9	0.9

Of the total of 510 patients, 62.3% of patients did not have an ICD implantation and reasons for non-utilization of ICD were assessed. The biggest reason for non implantation was that no discussion took place between the cardiologist and patient regarding the option of ICD placement (23.2% of cases). While the option was discussed in other cases, 22.6% of patients refused an ICD implant. In another 16.3% of patients, EF spontaneously improved to >35% more than a year later. Patients in NYHA class 1 contribute to 7.9% of patients. About 5.7% of patients were lost to follow-up after 2005 and 0.3% of patients died within one year of diagnosis before an ICD was discussed or implanted. Patients who died after more than a year after diagnosis of low EF were not included in this group, instead the other reasons why an ICD was not implanted in this group was ascertained and included in that category. Expected survival of less than a year like those who had end stage cancer were stated as reasons for ICD non implantation in 3.8% of patients. Similarly, low quality of life including dementia, psychiatric reasons was present 3.1% of patients. Comorbidities including COPD and obesity precluding ICD placement were observed in 1.9%. In another 4.7% of patients the option of ICD was discussed but not implanted. Either the patient died before an ICD was placed or had not followed up (1.8%). In other cases, the physician has not followed up on it at further clinic visits (2.8%) or discussed most recent visits (**Table 2**). In 9% of cases, miscellaneous reasons were cited such as an expected improvement in EF, or occluded bilateral subclavian vessels which precluded ICD implantation. This also included situations where ICD placement was deferred until treatment of co-existent medical conditions such as cancer or osteomyelitis were completed. Thus, in 44% of patients ICD implantation was discussed or considered even if the patients refused in 22% of cases. While all patients were seen by cardiologists, 25% of them were also seen by an electrophysiologist and 23% of those

encounters included discussion about ICD placement.

Table 2: Reasons for non-utilization of ICD therapy (n=318)

Reasons	Frequency	Percentage
Option not discussed (Not documented)	74	23.2%
Patients refused	72	22.6%
Percentage where EF improved > 1yr later	52	16.3%
Died	1	0.3%
NYHA class I	25	7.9%
NYHA class IV	5	1.6%
Lost to f/u	18	5.7%
Low 1 yr survival	12	3.8%
Low quality of life	10	3.1%
Comorbidities	6	1.9%
Discussed once but physician has not followed up	9	2.8%
Discussed but patients not followed	6	1.9%
Miscellaneous causes	28	8.9%
	318	100%

Discussion

Our study showed that only one third of patients with $EF \leq 35\%$ received an ICD for primary prevention of SCD. While optimal medical treatment with BB, ACE/ARB, diuretics and AA was close to goal even though not at 100%, ICD implantation rates for primary prevention of SCD were low. Our study identified the reasons for non-implantation of ICD with the most common being the physician not discussing the option of ICD placement. As expected, mortality in patients without the ICD was higher than those with ICD.

Mortality in our study was defined as all-cause mortality and it is unknown if most of these deaths were due to sudden cardiac death. It is possible that of the 9% (n=64) of patients who died prior to 2005 without an ICD some of them could have died of arrhythmic causes. Mortality was significantly higher in patients without an ICD after controlling for other factors including NYHA class.

Our study findings on medical management of heart failure are similar to those found in previous heart failure studies [13-15]. Efficacy of BB, ACEIs/ARBs and AA in HF has been well established [16-19] and >75% of patients in our study were on BB, ACE/ARB and ASA.

Utilization rates for AA were low but only 30% of patients in our study had NYHA class III and IV symptoms which explains the small percentage.

ICDs have also been shown to be cost effective [20]. However, the utilization rate of ICDs in patients with left ventricular dysfunction in our study and other studies has been poor [9-12,21]. In a recent study utilizing data from the Get-With the Guidelines data, hospital level variations were noted with rates as low as tertile of 1% to as high as 35% with an overall rate of 20% [9].

The reasons for the low rates of implantation were not described. Also, that study assessed the rates of implantation at discharge or plans for ICD placement following discharge and thus may not be an accurate representation of actual ICD placement. Patients with recent MI who may qualify for an ICD after 40 days may be lost to follow-up. Our study in contrast captures patients in an outpatient setting where patients are regularly followed up and the results are derived from the community rather than trial population. Some of the other studies evaluated gender and racial disparities in ICD implantation for primary and secondary prevention. Our study is different in that we assessed the reasons for non-implantation of ICD in ICD eligible primary prevention patients. There were no differences in race and gender in our study as suggested by previous trials [10-12]. Among patients who received an ICD in our population, the majority received it for primary prevention (96.7%). 45% of these were CRT-D devices and the rest were single chamber and dual chamber ICD's. Patients with ICD were also on higher rates of ACE/ARB, BB, AA and statins. It is also possible that patients considered for ICD implantation were first initiated on maximal medical management before an ICD was placed. It is also possible that these patients represent a select group who are compliant with their medications and thus considered further for an ICD. Patients with atrial fibrillation (AF) had a trend towards higher rate of ICD implantation. It is possible that patients with AF were referred to electrophysiologists who would have facilitated ICD placement. It is also possible that these patients had severe symptomatic cardiomyopathy causing atrial fibrillation and the more symptomatic patients were considered for an ICD implant.

Extensive review of the patient charts reveal that the absence of any kind of discussion regarding an ICD by the primary cardiologist to be the most common reason behind non ICD implantation in patients who otherwise met criteria for primary prevention ICD therapy. This observation opens up many speculative reasons for the physician's inability to address the need for an ICD. The physician may be unaware of the recent guidelines for heart failure management especially if the patient is being followed by a non-cardiologist. While maximizing medical therapy the issue of ICD may be deferred and never returns to discussion during follow up. It is also possible that cardiologists do not think of primary prevention with ICD therapy if patients presenting to their clinic are doing well symptomatically. Another barrier to ICD implantation may be the cost of the device. Other reasons for patients' refusal of ICD therapy could be the fear of being shocked, unawareness of the importance of ICD, or cultural differences in the perceptive needs for therapy.

A recent study by Al-khatib et al [22] contrasts completely from our study findings. ICD use at their institution was higher (60%). While this could represent institutional differences certain other factors listed below also could also have accounted for the differences in implantation rates. Their study population included all patients admitted to the hospital over a 6 month period alone. Our study is all inclusive of patients with low EF and not necessarily only patients admitted with heart failure to the hospital. Their study only included patients with EF<30% while ours considered everyone with EF< 35%. Their study only discusses percentage of patients who met criteria but had no ICD, ours goes a step further to assess if the ICD was ever recommended by the physician.

Our study demonstrates several important findings. The utilization rate of ICDs in HF

patients even in a large academic center with readily available quality cardiovascular care is suboptimal. Among patients with no ICD, the option was actually considered or discussed by physicians in 44% of patients even if the patients refused or had co-morbidities precluding implantation. Since another 22% either died or lost to follow-up or had improved their EF, attention should be directed to the remaining 24% of subjects where the option was never discussed. This can be achieved by targeting educational interventions towards the physicians. Likewise, patient refusal of the device was another major cause and interventions that increase patient awareness regarding the survival benefit of these devices may help greatly. When patients had refused an ICD device, there were no further discussions regarding ICD placement at subsequent visits. We believe that reinforcing the need for ICD placement at multiple visits may convince patients of its benefits.

Our study confirms that ICD implantation rates are not at goal and interventions should be targeted towards improving these rates. This can be done by using pop-ups in electronic medical records on patients with heart failure. Patients who refuse an ICD should be counseled at every visit and the pros and cons of ICD placement should be discussed. Another alternative is to refer to the heart failure clinic where a physician and/or a nurse practitioner would explain to the patient in detail about the benefits of ICD. Educational interventions and current performance awareness may ultimately help in improving the rates for ICD implantation for primary prevention.

Study limitations

This is a retrospective study at a single institution. Nevertheless this is a tertiary referral center with 30 cardiologists and an active electrophysiology program. It was assumed that ICD discussion did not take place if it was not documented in the medical record. Some selection bias may have been present since majority of patients were of Caucasian race. All-cause mortality and not cardiovascular mortality was recorded, so the exact cause of death in patients without an ICD are unknown.

Future studies

Oftentimes patients go through a chain of screening starting with the primary care physician, through a cardiologist and finally the electrophysiologist. It will be important to identify the origination of the recommendation for ICD therapy in the chain of decision making so as to determine targets for educational interventions.

Conclusions

This study suggests that the use of ICDs in patients with left ventricular systolic dysfunction is less than optimal and identifies the areas that need attention namely, physician discussion and reinforcement with the patient about ICD implantation and patient education about the benefits of the device.

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