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Research Article

Do African-Americans with Chronic Systolic Heart Failure Respond Differently to Cardiac Resynchronization Therapy-Defibrillator (CRT-D)? -

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ABSTRACT

Introduction: African-Americans with heart failure are known to have higher mortality and morbidity rates compared to other races with a variable response to therapies. There is a paucity of race-specific data on the benefit of Cardiac Resynchronization Therapy with Defibrillator (CRT-D) in patients with heart failure with reduced ejection fraction.

Objectives: Our study was designed to look at the pattern of response to CRT-D in African-American subset and determine predictors of recovery of left ventricular function.

Material and methods: Records of 212 patients with CRT-D at Albert Einstein Medical Center, Philadelphia between 2009 and 2013 were analysed for baseline, electrocardiogram, and echocardiogram characteristics. The African American (AA) cohort (n = 130) was compared with a Non-African American (Non-AA) group (n = 82) with respect to clinical outcomes and echocardiographic LV recovery.

Results: Improvement in LVEF by ≥5% from base line (primary outcome) was observed to be similar in both African-American and Non-African American groups (63% *vs*. 59.76%; *p*-value-0.71). The secondary clinical outcomes including major cardiac events, Inotropic dependence, number of total HF exacerbations, admissions, Telemetry/ICU admissions in 30 days, number of ICD shocks and ATP, 2-year mortality and event–free survival were comparable between the groups.

Conclusion: African-Americans with advanced heart failure showed response to CRT therapy similar to non-African American races. Among the AA, those with poor baseline ejection fraction and dilated left ventricle (LVEDD >6cm) were associated with less favourable response with CRT-D and this subset of patients should therefore be considered early for advance heart failure therapies such as ventricular assist devices or cardiac transplant.

Keywords: Cardiac resynchronisation therapy; Clinical outcomes; Heart failure; Race/ethnicity; African-Americans

INTRODUCTION

Over last 15 years, CRT has been proven to relieve symptoms, reduce the need for recurrent hospitalizations, improve quality of life, and reduce morbidity and mortality in patients with heart failure with reduced ejection fraction and wide QRS duration [1-5]. The REVERSE trial and MADIT-CRT found that these benefits can also be seen in less advanced stages of heart failure [6]. However, it is unclear whether race plays a role in response to CRT therapy. African-Americans (AA) with heart failure are known to have higher mortality and morbidity rates compared to other races are known to have differential response to several cardiac drugs [7]. It is unknown if AA may respond differently to CRT therapy. There is a paucity of race-specific studies in this area. Moreover, under-representation of certain racial/ethnic minorities in most trials raises questions about the rationale to adopt device recommendations uniformly in all races [8]. IMPROVE HF registry comprising of 8936 eligible heart failure patients, the mortality benefit was equivalent in white and black and other minority races. The authors suggested that race/ ethnicity should not be a factor for decision on device therapy for heart failure [9].

The objective of this study is to assess the proportion of responders to CRT-D therapy in African American patients compared to a non-African American population and to evaluate the clinical correlates of left ventricular recovery in African American patients.

MATERIALS AND METHODS

This retrospective study was designed as a single centre study at Albert Einstein Medical Center, Philadelphia, USA. A database maintained at by the implantable cardiac device clinic of AEMC was used and the records of the patients with known diagnosis of heart failure that had undergone CRT-D between 1st January 2009 to 31st December 2013 were screened. All adults (>18 years) of both sexes and of any race, diagnosed to have congestive heart failure of any cause, with LVEF ≤35% on echocardiogram and if ECG showed QRS > 120 msec were included for the study. Those not completing 24-month follow-up or having any documented non-compliance with medications, inadequate echocardiographic data and those with history of ongoing chemotherapy for active malignancies were excluded. Institutional Review Board approval was obtained for the conduct of the study along with waiver of consent from participants as the study employed only a retrospective chart-review method.

The primary outcome was the proportion of echocardiographic responders to CRT-D therapy in African American compared to other races at 2 years follow-up. The median time to echo used in study for assessing response was 303 days (Interquartile range 203-412 days). The secondary outcomes included number of hospitalizations in the subsequent 30 days and 2 years following implantation, ICD shocks and major cardiovascular events including acute coronary syndrome, stroke, cardiac surgery, LVAD, Cardiac transplant or cardiac arrest. Outcomes were measured over an average follow up at 24 months. Any differences in clinical or echocardiographic parameters in African-American *vs*. Non-African-American subsets were compared and analysed.

Echocardiographic responders: Echocardiographic studies done as per American Society of Echocardiography recommendations. An improvement in LVEF of at least 5% was taken as echocardiographic response and those who those who normalized EF to ≥50% were considered super-responders.

The 3-month data was taken as short-term and 24-month data was taken as long-term for the analysis. Age, BMI, presence of DM/ hypertension, significant CKD, QRS duration, LBBB or otherwise, pre-procedural LVEF, LA dimension, significant MR, RV dilatation, occurrence of ICD shocks or VT episodes are tested as possible predictors for response.

Statistical methods

Clinical data, medical history, medications, laboratory values, echocardiographic parameters were analysed. Significant improvement was defined as an increase in ejection fraction of at least 5% above the pre-CRT echocardiographic value. Continuous variables were represented as mean and standard deviation. Categorical variables were represented as frequencies and percentages. The statistical significance in the difference in the outcome variables between the groups and was assessed t-test and

Chi-square test, respectively. For studying intersubject variation in echocardiographic parameters over time post CRT, we used the paired t-test and McNamara's test for continuous and categorical variables respectively. Among the responders, a univariate analysis of possible predictors was evaluated. A multivariate model was created to assess for predictors of echocardiographic response using binary logistic regression and consisted of patient characteristics, EKG characteristics, comorbidities, echocardiographic parameters and underlying function NYHA class. The multivariate was repeated to assess for predictors of super-response compared to non-responders. *P*-value of <0.05 was taken to infer statistical significance. Data was analysed using SPSS V23.0 (Armonk, NY).

RESULTS

The Device clinic records at AEMC were screened and all patients with a diagnosis of heart failure who had undergone CRT in the last 5 years were selected. After applying the inclusion and exclusion criteria, there were 212 patients who had at least two-year follow-up data. Of them, 130 belonged to African-American race (AA group). The remaining 82 were grouped together as NAA group that included 49 Caucasians, 9 Asians, and 24 Hispanics.

Baseline characteristics

The base-line and clinical characteristics of the study population is given in table 1. The mean age and BMI were similar in both groups. Although males predominated in both groups, there are significant differences in the prevalence of male sex and ischemic heart disease in the NAA group. Smokers, alcoholics, hypertensive, diabetics and dyslipidaemia, chronic kidney disease was of similar proportions. The use of guideline directed medications for heart failure was similar in both groups. The NYHA class, the BP and heart rate and the ECG parameters were comparable in both groups. Pre-procedural ECHO parameters were similar in both groups [mean LVEF being 22.11 ± 8.19 *vs.* 24.65 ± 7.34 Mean LV ESD 5.05 ± 0.91 *vs.* 4.9 ± 0.85 cm and mean LV EDD 5.9 ± 0.82 *vs.* 5.83 ± 0.82 cm] (Table 2).

Primary outcome

The degree of increase in mean LVEF or reduction in mean LV dimensions was similar in AA (n = 130) and NAA (n = 82) groups. It was noted that response to CRT was similar irrespective of presence or absence of atrial fibrillation (Table 2). There were 81 [38.2%] non-responders of which 48 subjects (37.7%] were AAs and 33 subjects [40.2%] were non-AAs, p = 0.83. There was no significant difference in the response rates in AA and NAA groups [82(62.3%) *vs.* 49(59.76%); p-value-0.83] (Table 3). Super-responders were similar in both groups: 17.7% and 14.6% in AA and NAA respectively. Additionally, it was observed that there was only a negligible decrease in LV dimensions, but the occurrence of significant MR lessened following CRT implantation in both groups (Table 2).

Clinical outcomes

The major secondary clinical outcomes such as Inotropic dependence, HF admissions to Telemetry/ICU admissions in 30 days, number of ICD shocks and Anti-tachycardia pacing and VT episodes found on interrogation were comparable in both groups (Table 4). The rate of In-hospital mortality and all-cause Mortality within 2 years were also similar in the two groups.

Of the 130 patients in the AA group, 12.3% died by 2 years. All cause mortality at 2 years in NAA group (82 patients) was 11% (Table 4). Of the 114 African-Americans that were alive, 86 patients had clinical events such as HF exacerbations, ICD shocks/ATPs, ACS, stroke, LVAD/Cardiac transplant, inotropic dependence (75.4%). The corresponding number in the NAA group was 65 out of 73 (89.04%).

Table 1: Baseline characteristics of the study population.

Variable	African American (n = 130)	Non-African American (n = 82)	*p*-value
Age in years (Mean ± SD)	66.2 ± 11.8	66.3 ±11.8	0.92
Body mass index (kg/m^2) (Mean ± SD)	29.99 ± 8.11	29.42 ± 7.29	0.60
Male sex (no. %)	71 (54.62%)	61 (74.39%)	<0.01
Etiology: Ischemic	45 (34.62%)	47 (57.32%)	<0.01
NYHA functional class - II III IV	51 (39.23%) 50 (38.46%) 29 (22.3%)	33 (40.24%) 40 (48.78%) 09 (10.97%)	0.08
Hypertension (Blood pressure 140/90 mm Hg or above or use of antihypertensive medications)	128 (98.46%)	79 (96.34%)	0.32
Diabetes mellitus	69 (53.08%)	50 (60.98%)	0.25
Hyperlipidemia	109 (83.85%)	71 (86.59%)	0.58
Smoker, current	46 (35.38%)	26 (31.71%)	0.58
Alcohol use, current	25 (19.23%)	15 (18.29%)	0.92
Drug abuse, current	17 (13.08%)	8 (9.76%)	0.44
CKD stage III and above	30 (23.07%)	21 (25.61%)	0.67
SBP (mm Hg) (Mean ± SD) DBP (mm Hg) (Mean ± SD) Heart rate (beats per minute) (Mean ± SD)	129.92 ± 18.1 76.41 ± 9.51 78.58 ± 9.87	129.2 ± 16.47 75.38 ± 12.17 79.89 ± 12.37	0.77 0.49 0.39
EKG: Atrial fibrillation/flutter Mean QRS> 150 msec (Mean ± SD) PR (msec) (Mean ± SD) QTc (Mean ± SD) LBBB (Mean ± SD)	47 (36.15%) 142.65 ± 27.22 167.09 ± 49.46 493.3 ± 45.12 62 (47.6%)	28 (34.15%) 151.45 ± 27.7 167.09 ± 49.4 493.11 ± 43.57 38 (46.34%)	0.76 0.02 0.85 0.97 0.96
Mean LVEF (%) Mean LVESD (cm) Mean LVEDD (cm) Left atrial dimension (cm) Mitral regurgitation (moderate to severe) Right ventricle dilatation	22.10 ± 8.18 5.05 ± 0.91 5.92 ± 0.84 4.54 ± 0.72 37 (28.46%) 41 (32.28%)	24.65 ± 7.34 4.90 ± 0.88 5.83 ± 0.80 4.65 ± 1.00 21 (25.61%) 29 (35.36%)	0.02 0.25 0.46 0.36 0.65 0.62
Diuretics ACEI/ARBs Beta-blockers Spironolactone Hydralazine/nitrates Digitalis Statins	130 (100%) 115 (88.5%) 130 (100%) 64 (49.23%) 129 (99.23%) 29(22.31%) 109(83.8%)	82 (100%) 70 (87.5%) 81(98.7%) 27 (32.93%) 64 (78.05%) 14(17.07%) 71(86.59%)	0.99 0.70 0.19 0.02 <0.01 0.35 0.58

CKD: Chronic Kidney Disease; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; EKG: Electrocardiogram; LLVEF= Left Ventricular Ejection Fraction; LVEDD= Left Ventricular End-Diastolic Dimension; LVESD= Left Ventricular End-Systolic Dimension.

Predictors of response

Several possible predictors influencing the positive response were evaluated by univariate and multivariate analysis (Table 5 & 6). Age, BMI, presence of DM/hypertension, significant CKD, QRS duration, LBBB or otherwise, pre-procedural LVEF, LA dimension, significant MR, RV dilatation, or occurrence of ICD shocks did not predict the responders in AA or NAA groups. Men had better response than women especially in NAA group while AA group has not

shown similar phenomenon. In the subgroup multivariate analysis performed for super-responders, only LVEDD of ≥6 cm predicted lower chance of being a super-responder (aOR 0.10, 95% CI 0.02-0.38; $p = 0.001$).

Survival data

The mortality at 30-days and 2 years were not significantly different in AA and NAA groups.

Table 2: Echocardiographic response in each group.

Variable		Pre CRT-D	Post CRT-D	p-value
African American (n = 130)	LVEF (%)	22.11 ± 8.19	32.02 ± 14.24	<0.01
	LVESD (cm)	5.05 ± 0.91	4.65 ± 1.27	<0.01
	LVEDD (cm)	5.92 ± 0.84	5.72 ± 1.09	0.01
	Moderate-severe MR (%)	37(28.4%)	20(15.3%)	<0.01
Non-African American (n = 82)	LVEF (%)	24.66 ± 7.34	32.34 ± 12.71	<0.01
	LVESD (cm)	4.9 ± 0.88	4.66 ± 1.11	0.02
	LVEDD (cm)	5.83 ± 0.80	5.79 ± 0.92	0.54
	Moderate-severe MR (%)	21(25.6%)	13(15.8%)	0.13

CRT-D: Cardiac Resynchronization Therapy Defibrillator; LVEF: Left Ventricular Ejection Fraction; LVESD: Left Ventricular End Systolic Diameter; LVEDD: Left Ventricular End Diastolic Diameter; MR: Mitral Regurgitation.

Table 3: Echocardiographic super-responders, responders and non-responders in both groups.

Variable	African American (n = 130)	Non-African American (n = 82)	*p*-value
Overall			0.83
Non-responder (%)	37.7	40.2	
Responder (%)	44.6	45.1	
Super-responder (%)	17.7	14.6	
Sinus Rhythm			0.43
Non-responder (%)	32.5	40.7	
Responder (%)	49.4	48.1	
Super-responder (%)	18.1	11.1	
Atrial fibrillation/flutter			0.79
Non-responder (%)	46.8	39.3	
Responder (%)	36.2	39.3	
Super-responder (%)	17.0	21.4	

Table 4: Secondary outcomes in study groups.

Variables	African American	Non-African American	*p*-value
Inotrope dependence (%)	3.1	2.5	0.79
Readmission to cardiovascular service within 30-days (%)	16.9	19.5	0.63
Readmission to cardiovascular service within 2-years (%)	66.9	65.9	0.87
Readmission for acute HF exacerbation within 2-years (%)	37.7	45.1	0.28
Experienced ICD shock pacing within 2-years (%)	16.2	12.2	0.42
Anti-tachycardia pacing within 2-years (%)	20	15.9	0.44
At least one major cardiac event* within 2-years* (%)	23.1	13.4	0.08
In-hospital mortality within 2-years (%)	6.2	4.9	0.69
All-cause mortality at 2-years (%)	12.3	11.0	0.77

*Composite event consisting of at least one of the following: Acute Coronary Syndrome; Stroke; Cardiac Surgery; Left Ventricular Assist Device Placement; Heart Transplant; Cardiac Arrest.

Table 5: Univariate predictors of response to CRT therapy within multivariate model.

	Non-responder (n = 82)	Responder (n = 130)	p-value
African American race (%)	59.8	62.3	0.71
Age in years	66.5 ± 11.8	66.0 ± 11.6	0.75
Female sex (%)	32.9	40.8	0.25
Body mass index ≥30kg/m^2 (%)	40.2	44.6	0.53
EKG parameters (%)			0.35
Baseline LBBB	42.7	50.0	
Baseline RBBB	17.1	10.8	
Baseline IVCD	40.2	39.2	
Diabetes (%)	61	53.1	0.25
Hypertension (%)	97.6	97.7	0.95
Hyperlipidemia (%)	90.2	81.5	0.08
Non ischemic Cardiomyopathy (%)	50	60.8	0.12
Atrial fibrillation or flutter (%)	40.2	32.3	0.23
Current smoker (%)	35.4	33.1	0.73
Current alcohol use (%)	24.4	15.4	0.10
Current drug abuse (%)	13.4	10.8	0.56
Left Ventricular ejection fraction (%)	24.6 ± 7.3	22.1 ± 8.1	0.02
LVEDD ≥6cm (%)	54.9	40.0	0.03
Moderate to severe mitral regurgitation (%)	22.0	30.8	0.16
NYHA functional class (%)			0.71
Class II	42.7	37.7	
Class III	41.5	43.1	
Class IV	15.9	19.2	

LBBB: Left Bundle Branch Block; RBBB: Right Bundle Branch Block; IVCD: Intraventricular Conduction Delay; LVEDD: Left Ventricular End Diastolic Diameter; NYHA: New York Heart Association.

DISCUSSION

Cardiac Resynchronization therapy for advanced systolic heart failure is evidence-based and widely practiced strategy. MADIT-I and MADIT-II established the use of prophylactic ICD in ischemic cardiomyopathy in early 2000s. CRT therapy gained importance after its clinical benefits of improvement of symptoms and exercise capacity as well as marked reduction in hospitalisations in HF patients were realised subsequently [2]. Following CRT, reverse ventricular remodelling was found consistently at 6-month follow-up with up to 15% reduction in echo derived LVEDD and about 6% increase in LVEF more so in the non-ischemic Cardiomyopathy [8]. Reduction in hospitalisation for CV events and mortality benefit was proven in subsequent trials including the CARE-HF and MADIT-CRT trials, the latter showing about 34% relative risk reduction in mortality [10,11]. The benefits of CRT/CRT-D to improve the outcomes in chronic heart failure were proven without ambiguity and it entered various heart failure guidelines endorsing it as class I recommendation for select patients [12,13]. Despite this data, large cohorts of African American patients have not been widely studied.

Based on previous studies in other areas of cardiology, there is a concern that AAs may respond differently to CRT compared to non-AA cohort. Heart failure is more prevalent in African American population, occurs at early age and is more severe than that is seen in

Table 6: Predictors of response to CRT therapy within multivariate model.

Variable	Adjusted Odds Ratio	Lower 95% Confidence intervals	Lower 95% Confidence intervals	*p*-value
African American race	0.87	0.45	1.67	0.67
Age	1.00	0.97	1.03	0.89
Female sex	0.87	0.43	1.78	0.70
Body mass index ≥30kg/sqm	1.73	0.86	3.46	0.12
Underlying RBBB versus LBBB	1.67	0.65	4.28	0.29
Underlying IVCD versus LBBB	1.38	0.53	3.61	0.51
Diabetes	0.81	0.43	1.54	0.52
Hypertension	2.08	0.23	18.96	0.52
Hyperlipidemia	0.47	0.18	1.27	0.14
Non ischemic Cardiomyopathy	1.42	0.73	2.75	0.30
Atrial fibrillation or flutter	0.62	0.32	1.18	0.14
Current smoker	0.95	0.47	1.93	0.89
Current alcohol use	0.51	0.20	1.27	0.15
Current drug abuse	1.13	0.35	3.61	0.84
Left ventricular ejection fraction	0.95	0.91	0.99	0.02
LVEDD ≥6cm	0.34	0.17	0.67	0.00
Moderate to severe mitral regurgitation	1.54	0.74	3.23	0.25
NYHA functional class III versus Class II	1.24	0.61	2.50	0.55
NYHA functional class IV versus Class II	1.37	0.55	3.38	0.50

LBBB: Left Bundle Branch Block; RBBB: Right Bundle Branch Block; IVCD: Intraventricular Conduction Delay; LVEDD: Left Ventricular End Diastolic Diameter; NYHA: New York Heart Association.

the whites [14,15]. The annual incidence of heart failure in whites is approximately 6 per 1,000-person years, while in African Americans it is 9.1 per 1,000 person-years [14]. In CARDIA (Coronary Artery Risk Development in Young Adults), study in persons <50 years, 26 out of 27 incident heart failure belonged to AA race [14,15]. In a long follow-up studies –ARIC and MESA, after statistical adjustment for established risk factors, the discrepancies between the AA and Whites persisted in the women but not in men. In those with young age at onset discrepancy was more evident [16,17].

Bibbins-Domingo et al reported that heart failure before age 50 was 20 times more frequent in African Americans than in whites [15]. Some studies have reported higher rates of hospitalizations in the African American cohort [18,19]. This could be probably explained by higher prevalence of hypertension, diabetes and obesity in these races. The disparities in the outcomes in African-Americans following various therapies in HF can be multi-factorial and may involve an interplay of environment, social factors and genetic composition [20]. The influence of gene polymorphism on LV reverse remodelling following CRT is not fully understood and still evolving. Genetic variations in salt-sensitivity and response to RAS blockade have been identified in cardiac patients. AASK study had shown that AA who were homozygous for the ACE polymorphism responded well to ACE inhibitors but not to CCBs compared to those heterozygous [21]. Nishio K et al demonstrated that the higher incidence of ACE related adverse effects in AA is due to ACE enzyme and bradykinin gene polymorphism [22,23].

In another study, Pezzali and Curnis found that Glu27Glu carriers (ARs gene polymorphism) showed greater LV reverse remodelling after CRT and lesser incidence of malignant ventricular tachyarrhythmias [24].

Most heart failure trials included about 20% African Americans and they have never been studied exclusively, except in the African American Heart failure trial [AHeFT] testing Isosorbide dinitrate/hydralazine. Several major trials like CARE-HF, MIRACLE-ICD, MADIT-CRT and CHAMPIAN trials have proven to improve clinical outcomes and some recovery of LV systolic function following CRT therapy. However, these data included heterogenous population and African American cohort were not widely studied in these CRT trials and sub-group analysis are limited [25]. In a recent analysis (IMPROVE HF registry) the use of CRT therapy was associated with reduced 24- month mortality in African-Americans which was comparable to other races [9].

This study was undertaken, in view of paucity of literature on the response to CRT-D in African-American heart failure patients. Our study comprised of 130 AA patients constituting about 61% of the cohort, a substantially larger representation than most traditional studies. We found that African-Americans had a similar response to CRT-D therapy as compared to the non-African American patients. The degree of increase in mean LVEF or reduction in mean LV dimensions was similar in AA and NAA groups. The clinical outcomes such as major cardiac events (ACS, stroke, LVAD/Cardiac transplant of other cardiac surgeries), inotropic dependence, number of total HF exacerbations, admissions, telemetry/ICU admissions in 30 days, number of ICD shocks and ATP, VT episodes found on interrogation were comparable in both groups. Rates of in-hospital mortality and all-cause mortality within 2 years were similar in the two groups.

All patients in our study were on goal directed therapy and several possible predictors influencing the positive-response or super-response were evaluated. Age, BMI, presence of DM/hypertension, significant CKD, QRS duration, LBBB or otherwise, LA dimension, significant MR, RV dilatation, occurrence of ICD shocks or VT episodes did not predict the response or super-response in AA or NAA groups.

In the multivariate analysis, although female sex and LBBB trended to benefit from CRT-D, surprisingly NICM increased hazard ratio and AF reduced it. The wide confidence interval could be due to low study numbers. It is unclear why we NICM increased the hazard ratio and atrial fibrillation reduced it.

Irrespective of race, subjects with poor baseline ejection fraction and dilated left ventricle (LVEDD >6cm) were associated with less favourable response with CRT-D and this subset of patients should therefore be considered early for advance heart failure therapies such as ventricular assist devices or cardiac transplant.

A small prospective study on 75 patients followed for 17.9 months following CRT therapy, identified that baseline QRS < 150 msec, > 40 msec of QRS shortening following CRT, and non-ischemic etiology are important predictors for full response [26]. Goldenberg analysed the MADIT-CRT database and identified that female sex, non-ischemic origin, LBBB, QRS > 150 msec, prior hospitalisation for HF, LVEDV> 125 ml/mt2 and LA volume >40ml/mt2 are the seven

predictors that predict good response [11]. In MADIT-CRT trial, 1820 patients were followed for 2.4 years following ICD/CRT-ICD. The primary end-point which was non-fatal heart failure or death from any cause, was seen in 25.3% in ICD group and in 17.2% in the CRT group. There was significant increase in LVEF and reduction in LV volumes. Both ischemic and non-ischemic groups benefited in the same way. Those with QRS width of > 150 msec responded the best [6]. The long-term results of MADIT-CRT were also equally promising with persistent benefits seen in the patients with mild heart failure with LBBB regardless of sex, duration of QRS or cause of cardiomyopathy [27].

In the IMPROVE HF registry comprising of 8936 eligible patients, the 24-month mortality rate was evaluated in various races following CRT-D/CRT-P therapy. Clinical benefit was seen with the therapy with adjusted odds ratio of 0.64 for 24-month mortality. However, the benefit was equivalent in white and black and other minority races. The authors concluded that race/ ethnicity should not be a factor for decision on device therapy for heart failure [9]. Our study specifically focussed on this issue.

Rickard et al compared reverse ventricular remodelling and long-term outcomes in 88 AAs versus 574 European Americans with advanced heart failure on CRT. The survival and ventricular remodelling were found to be similar in both groups [28]. In our study we could add a greater number of AAs compared to Rickard's cohort.

STUDY-LIMITATIONS

This is a retrospective single centre study and therefore the total sample size is limited. This study was spread over 5 years with multiple operators doing the CRT-D and the echocardiographic testing can add to the challenges. Hence the assessment of response to CRT using the definition of improvement >5% of EF can have some inherent fallacy. Of those excluded, patients were lost to follow-up due to patient non-compliance for follow-up visits. This may be due to the fact that the study centre mainly caters to the inner-city--population of north Philadelphia which comprises of about 40 % African-Americans who belong to the lower economic strata of the community.

CONCLUSIONS

African-Americans with advanced heart failure showed response to CRT therapy similar to non-African American races in our retrospective single centre study and the clinical outcomes at 2-year follow-up were also comparable. There were no robust pre-procedural predictors to predict the degree of response in any group. Subjects with poor baseline ejection fraction and dilated left ventricle (LVEDD >6cm) were associated with less favourable response with CRT-D and this subset of patients should therefore be considered early for advance heart failure therapies such as ventricular assist devices or cardiac transplant.

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