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Morbidity and mortality with cardiac resynchronization therapy with pacing vs. with defibrillation in octogenarian patients in a real-world setting

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Aims Cardiac resynchronization therapy (CRT) with a defibrillator (CRT-D) has downsides of high cost and inappropriate shocks compared to CRT without a defibrillator (CRT-P). Recent data suggest that the survival benefit of implantable cardioverter defibrillator (ICD) therapy is attenuated in the older age group. We hypothesized that, among octogenarians eligible for cardiac resynchronization therapy, CRT-P confers similar morbidity and mortality benefits as CRT-D.

Methods and results We compared morbidity and mortality outcomes between consecutive octogenarian patients eligible for CRT therapy who underwent CRT-P implantation at Barzilai MC ($n = 142$) vs. those implanted with CRT-D for primary prevention indication who were prospectively enrolled in the Israeli ICD Registry ($n = 104$). Among the 246 study patients, mean age was 84 $\pm$ 3 years, 74% were males, and 66% had ischaemic cardiomyopathy. Kaplan–Meier survival analysis showed that at 5 years of follow-up the rate of all-cause mortality was 43% in CRT-P vs. 57% in the CRT-D group [log-rank $P = 0.13$; adjusted hazard ratio (HR) = 0.79, 95% CI 0.46–1.35, $P = 0.37$]. Kaplan–Meier analysis also showed no significant difference in the rates of the combined endpoint of heart failure or death (46 vs. 60%, respectively, log-rank $P = 0.36$; adjusted HR was 0.85, 95% CI 0.51–1.44, $P = 0.55$). A Cox proportional hazard with competing risk model showed that re-hospitalizations for cardiac cause were not different for the two groups (adjusted HR 1.35, 95% CI 0.7–2.6, $P = 0.37$).

Conclusion Our data suggest that, in octogenarians with systolic heart failure, CRT-P therapy is associated with similar morbidity and mortality outcomes as CRT-D therapy.

Keywords Cardiac resynchronization therapy • Octogenarians • Morbidity • Mortality

Introduction

The older population remains largely under-represented in most implantable cardioverter defibrillator (ICD) and cardiac resynchronization therapy with defibrillator (CRT-D) trials.[1] The use of CRT-D or cardiac resynchronization therapy with pacing (CRT-P) in clinical practice is an important question, with significant implications in terms of costs,[2,3] as well as inappropriate shocks[4] and device-related complications.[5,6] Furthermore, advanced co-morbidities that are more common in the older age groups[1] may attenuate the survival benefit of ICD therapy.[7]

Sub-analyses of several randomized control trials suggested that ICD therapy is associated with a reduction in all-cause mortality in older patients compared with younger ones.[1,8,9] However, in a

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What's new?

- We compared morbidity and mortality outcomes between octogenarian patients eligible for cardiac resynchronization therapy (CRT) therapy who underwent cardiac resynchronization therapy with pacing (CRT-P) implantation vs. those implanted with cardiac resynchronization therapy with defibrillator (CRT-D) for primary prevention indication.
- At 5 years of follow-up the rate of all-cause mortality was not statistically different between CRT-P vs. CRT-D groups.
- There was no significant difference in the rates of the combined endpoint of heart failure or death.
- Re-hospitalizations for cardiac cause were not different for the two groups.

Our data suggest that, in octogenarians with systolic heart failure, CRT-P therapy is associated with similar morbidity and mortality outcomes as CRT-D therapy.

meta-analysis including five primary prevention ICD trials,[10] ICD therapy in older patients was not associated with a significant reduction in mortality. Furthermore, recent data suggest that mortality among older patients who receive cardiac resynchronization therapy is mostly due to non-sudden cardiac death causes,[11] and that the risk of ventricular tachyarrhythmias is attenuated in this population.[12,13]

Accordingly, we hypothesized that implantation of a CRT-P device will confer similar morbidity and mortality benefit as CRT-D therapy in a population of octogenarians with systolic heart failure (HF) and a prolonged QRS duration who were enrolled and prospectively followed up in a real-world setting.

Methods

Study design and population

CRT-P group: The study group included all consecutive patients ≥80 years who underwent CRT-P implantation according to guidelines (*de novo* implantation or upgrade from a permanent pacemaker) in Barzilai University Medical Center between 2006 and 2013 ($n = 142$). Patients were enrolled and prospectively followed up in a local registry. Inclusion criteria were: ejection fraction (EF) ≤ 35% with congestive heart failure (CHF) and QRS ≥ 120 ms; or EF ≤ 40% with either complete atrio-ventricular (AV) block or with atrial fibrillation (AF) and rapid ventricular response despite rate-control drugs that were planned for future AV node ablation. The registry was approved by the ethics committee of our institution, and all patients provided written informed consent.

CRT-D group: The study group was compared to a control group of patients ≥80 years that were implanted with CRT-D for primary prevention of sudden cardiac death according to guidelines[14] and were enrolled in the Israeli ICD Registry between 2010 and 2015 ($n = 104$). We did not include upgrades from ICD to CRT-D but included upgrades from pacemakers to CRT-D. The Israeli Registry is a prospective registry of all patients undergoing implantation or replacement of an ICD or CRT-D in all 22 implanting centres in the country. The registry is a collaborative effort between the community of cardiac electrophysiologists, care providers, industry, and payers, and is managed by the Israeli Association for Cardiovascular Trials (I-ACT). The registry was approved by the ethics committee of each participating institution, and all patients provided written informed consent. For the purpose of the present study, we included only patients undergoing *de novo* CRT-D implantation.

For the present study we combined the two data sources. Accordingly, the total study population comprised 246 patients.

Data collection and follow-up

For the study population in Barzilai University Medical Center, data were prospectively collected in a registry of all patients implanted with CRT-P in this centre. Data were collected from the index hospitalization at the time of initial CRT-P implantation or device upgrade. Collected variables included demographic and clinical characteristics, indication for device implantation, comorbidities, electrocardiogram, left ventricular EF, haemoglobin concentration and serum creatinine levels, previous treatments, device manufacturer, device type, and unique device identifier. Follow-up was of study patients enrolled between 2006 and 2013. Follow-up visits were initiated within 3 months of device implantation and subsequently at 6-month intervals thereafter. Clinical and device-related events occurring during follow-up were captured during device clinic visits from patient interviews, hospitalization records, and a national population registry.

For the control group of CRT-D patients from the Israeli ICD Registry, data were prospectively collected from the index hospitalization at the time of initial device implantation by the local electrophysiologist at the implanting centre and entered into a secure (firewall- and password-protected) web-based electronic case report form. Collected variables were similar to the CRT-P group. Follow-up was of study patients enrolled between July 2010 and February 2015. All patients who have had their devices implanted at the 22 participating centres continued to have their devices followed at the implanting hospital. Follow-up visits were initiated within 3 months of device implantation and subsequently at 6-month intervals. Clinical and device-related events occurring during follow-up were captured during device clinic visits at the implanting hospital from patient interviews, hospitalization records, national population registry, and contact by the Registry coordinator with the primary care physician. Completeness of the data regarding clinical events and its quality was continually assessed by the coordinating centre (I-ACT) through data checks and monitoring visits at the Registry sites.

Study endpoints

Study endpoints were as follows: death, time to first hospitalization and readmission to hospital for the management of HF, and the combined endpoint of HF or death.

Statistical analysis

Baseline patient clinical characteristics and procedural data were compared for the CRT-P vs. the CRT-D groups. The χ^2 test was used for dichotomous variables; analysis of variance was used for continuous variables.

A logistic regression was used to create propensity score. Baseline variables and interactions were regressed in order to calculate conditional predictive probability for each subject to be in the CRT-P group. Variables entered into the model included: age, gender, history of IHD, prior stroke, dyslipidemia, hypertension, diabetes mellitus, and New York Heart Association (NYHA) class. Interaction terms included age and gender. The predictive probability, a continuous variable (0–1), was then stratified into five quintiles and added as a propensity score in the multivariate analysis.

Survival plots were created using Kaplan–Meier method to compare between CRT-P and CRT-D. *P*-value was calculated using log-rank test with a *P*-value <0.05 considered significant.

In order to evaluate the association between death and CHF to cardiac resynchronization therapy (CRT) groups, a multivariate analysis was performed using a Cox proportional hazards regression model adjusting for the propensity score in model. Since CHF event-free might be partially due to missed opportunity to observe CHF before death, an analysis of CHF outcome was performed as a competing risk model using Fine and Gray's approach for modelling, where a death event was defined as a competing event and CHF was defined as an event of interest.

The I-ACT at Sheba Medical Center performed all statistical analysis. Data were analysed using SAS statistical software (version 9.4, SAS Institute, Inc., Cary, NC, USA).

Results

Patient population

Among the total 246 study patients, mean age was 83.5 ± 3 years; 74% were males and 66% had ischaemic cardiomyopathy. The CRT-P group included a total of 142 patients and the CRT-D group included 104 patients. Baseline demographic and clinical characteristics of the two groups are presented in *Tables 1* and *2*.

Compared to patients in the CRT-D group, those who received CRT-P therapy displayed a higher frequency of baseline clinical risk factors, including an older age and more advanced HF symptoms. In the CRT-D group, the proportions of males were higher vs. the CRT-P group and they had increased frequency of ischaemic heart disease. Other co-morbidities and medications were not significantly different between the two groups (*Tables 1* and *2*).

Table 1 Baseline demographic and clinical characteristics of study population

Variable	CRT-D (*N* = 104)	CRT-P (*N* = 142)	*P*-value
Age—mean (years)	82.3 ± 2.4	84.5 ± 3.0	<0.001
Age—median (range, years)	82 (81–83)	84 (83–86)	<0.001
Male	89 (86%)	92 (65%)	<0.001
Medical history			
Permanent pacemaker	18 (17%)	41 (29%)	0.036
Pacemaker dependent	8 (8%)	17 (12%)	0.27
Ischaemic heart disease	62 (87%)	101 (71%)	0.009
Prior CABG	49 (47%)	34 (24%)	<0.001
NYHA class ≥II	104 (100%)	133 (94%)	<0.001
AF/flutter	40 (38%)	64 (45%)	0.07
Prior CVA	17 (16%)	25 (18%)	0.8
Chronic lung disease	10 (10%)	10 (7%)	0.5
Dyslipidemia	72 (69%)	96 (68%)	0.8
Chronic renal failure on dialysis	2 (2%)	4 (3%)	1.000
Hypertension	83 (81%)	117 (82%)	0.7
Diabetes mellitus	45 (44%)	46 (32%)	0.07

Data are presented as *n* (%) of the patients with available data or as mean ± SD.
AF, atrial fibrillation; CABG, coronary artery bypass graft; CRT-D, cardiac resynchronization therapy-defibrillator; CRT-P, cardiac resynchronization therapy-pacemaker; CVA, cerebrovascular accident; NYHA, New York Heart Association.

Risk of mortality by device type

Kaplan–Meier survival analysis (*Figure 1*) showed that at 5 years of follow-up the cumulative probability of all-cause mortality was non-significantly lower in the CRT-P group compared with the CRT-D group (43 vs. 57%, respectively, log-rank $P = 0.13$ for the overall difference during follow-up between the two groups). Consistently, the adjusted hazard ratio (HR) of mortality between the CRT-P and CRT-D groups (adjusted for age, sex, and propensity score) was 0.79 (95% CI 0.46–1.35; $P = 0.37$) (*Table 3*).

Risk of mortality and heart failure events by device type

Consistent with the all-cause mortality outcome, Kaplan–Meier analysis (*Figure 2*) showed that at 5 years of follow-up the cumulative combined probability of a first hospitalization for HF or all-cause mortality (whichever occurred first) was similar between CRT-P and CRT-D patients (46 and 60% respectively; log-rank $P = 0.36$ for the overall difference during follow-up between the two groups). Similarly, multivariate analysis (adjusted for age, sex, and the propensity score for CRT-P implantation), did not show a statistically significant difference between CRT-P vs. CRT-D patients with regard to the combined endpoint of a first HF hospitalization or all-cause mortality [HR = 0.85 (95% CI 0.51–1.44); $P = 0.55$] (*Table 3*).

Risk of hospitalizations

There was no significant difference in the number of hospitalizations between the two patient groups (56% for both, $P = 0.95$).

Of the 142 CRT-P patients, 81 patients had available data regarding cause of first hospitalization. Of the 104 CRT-D patients, 51 patients had available data regarding cause of first hospitalization. *Figure 3* shows that in both CRT-P and CRT-D groups the most common cause of hospitalization after implantation was a non-cardiac cause.

A Cox proportional hazard with competing risk model was performed, where mortality was a competing event and cardiac re-hospitalization was an event of interest. It showed that re-hospitalizations for cardiac cause were not different between the CRT-P and CRT-D groups (adjusted HR 1.35, 95% CI 0.7–2.6, $P = 0.37$) (*Table 3*).

Discussion

Our study analysed a group of octogenarian patients with HF and decreased left ventricular (LV) function implanted with CRT-P in a single centre in a 'real-world scenario', and compared them to a CRT-D group of octogenarian patients from the Israeli ICD Registry. This registry has a prospective nature with detailed longitudinal follow-up. We found that at 5 years of follow-up there was no statistical difference between the CRT-P and the CRT-D groups regarding all-cause mortality and the combined outcome of all-cause mortality and first hospitalization for HF. Although there was a trend

Table 2 Baseline medications and laboratory studies of the study population

Variable	CRT-D (*N* = 104)	CRT-P (*N* = 142)	*P*-value
Medications on admission			
ACE-I/ARB	76 (74%)	98 (70%)	0.46
Beta blockers	79 (77%)	112 (79%)	0.6
Antiarrhythmic	18 (18%)	22 (16%)	0.8
Thienopyridine anti-platelet	19 (24%)	28 (20%)	0.45
Aspirin	57 (73%)	92 (65%)	0.2
Coumadin	21 (27%)	38 (27%)	0.99
Diagnostic and laboratory studies			
LVEF moderate dysfunction (30–39%), mean ± SD	28 (27%)	23 (16%)	0.001
LVEF Severe dysfunction (<30%), mean ± SD	75 (72%)	101 (71%)	0.001
QRS duration—mean (ms)	133.8 ± 30.4	134.0 ± 32.4	0.9
QRS duration—median (range, ms)	136 (118–160)	138 (115.5–158)	0.9
Haemoglobin—mean (g/dL)	12 ± 1.9	12.7 ± 1.7	0.015
Haemoglobin—median (range, g/dL)	12.4 (10.8–13.2)	12.4 (11.6–14)	0.015
eGFR—mean (median, mL/min/1.73 m^2)	57 ± 52.7 (52)	49.4 ± 19.4 (47.5)	0.152
Creatinine—mean (mg/dL)	1.7 ± 2.1	1.5 ± 0.7	0.87
Creatinine—median (range, mg/dL)	1.3 (1.1–1.8)	1.4 (1.1–1.7)	0.868

Data are presented as *n* (%) of the patients with available data or as mean ± SD.
ACE-I/ARB, angiotensin-converting enzyme inhibitor/angiotensin receptor blocker; CRT-D, cardiac resynchronization therapy-defibrillator; CRT-P, cardiac resynchronization therapy-pacemaker; LVEF, left ventricular ejection fraction; eGFR, estimated glomerular filtration rate.

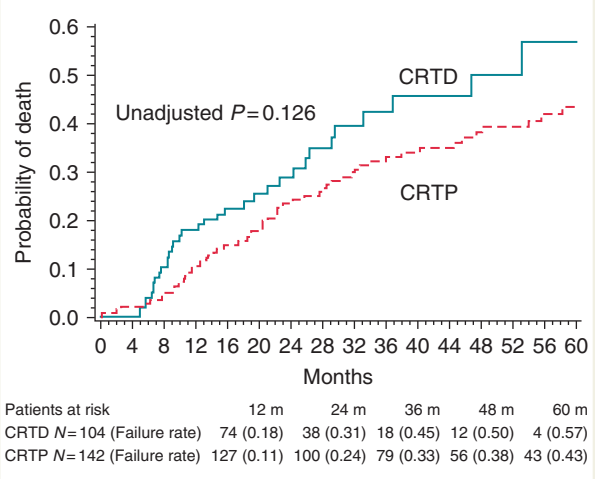

Figure 1 Kaplan–Meier estimate of the probability of all-cause mortality among octogenarians implanted with CRT-P vs. CRT-D.

Table 3 Risk of endpoints—adjusted model for survival and CHF

CRT-P endpoint (vs. CRT-D)	Adjusted HR[a]	CI 95%	*P*-value
Mortality	0.79	0.46–1.35	0.37
Combined mortality and CHF	0.85	0.51–1.44	0.55
Cardiac re-hospitalization[b]	1.35	0.70–2.61	0.372

CHF, congestive heart failure; CI, confidence interval; CRT-D, cardiac resynchronization therapy-defibrillator; CRT-P, cardiac resynchronization therapy-pacemaker; HR, hazard ratio.
[a]Model was adjusted for age, sex, and propensity score.
[b]A cox proportional hazard with competing risk model was performed, where mortality is a competing event and cardiac re-hospitalization is an event of interest.

towards a higher risk of first hospitalization for HF in the CRT-P group, it did not reach statistical significance. We found no significant difference in the number of hospitalizations between the two patient groups, and in both CRT-P and CRT-D groups the most common cause of hospitalization after implantation was a non-cardiac cause. Re-hospitalizations for cardiac cause were not different between the groups. These findings suggest that in octogenarian patients, implantation of CRT-P alone without defibrillator therapy can be considered as an alternative to CRT-D.

Despite the fact that the elderly population is growing in Western countries, implantation of ICD/CRT-D in an older population with HF is still debatable because prospective randomized trials of ICD and CRT-D therapy enrolled mostly younger patients who had a mean age less than 65 years. The prevalence of HF and the mortality associated with HF increases directly with age.[15] Furthermore, advanced co-morbidities that are more common in the older age groups[1] may attenuate the survival benefit of ICD therapy.[7] Thus, caution should be exhibited when extrapolating data to an older population. The 2013 European Society of Cardiology Task Force had the opinion that no strict recommendations can be made, and merely offered guidance regarding the selection of patients for

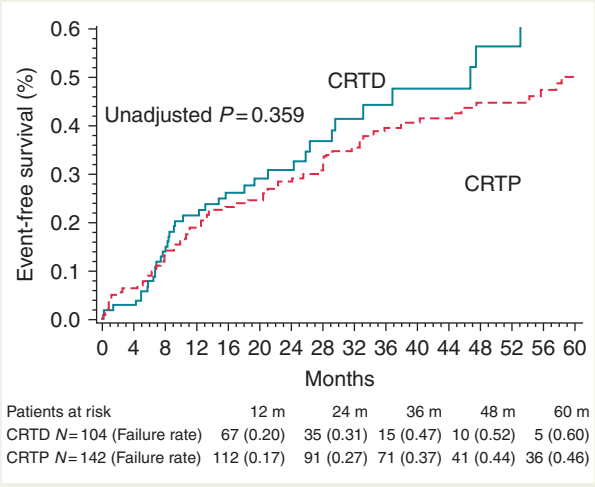

Figure 2 Kaplan–Meier estimate of the probability of survival free of combined endpoint (all-cause mortality and first hospitalization for heart failure) among octogenarians implanted with CRT-P vs. CRT-D.

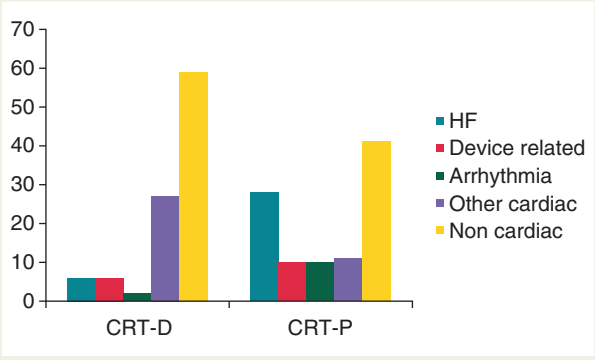

Figure 3 Histogram of causes of first hospitalization—CRT-D vs. CRT-P.

CRT-D vs. CRT-P, based on overall clinical condition, device-related complications, and cost.[14] Our data further support these recommendations, suggesting that in the octogenarian age-group treatment with CRT-P may be non-inferior to CRT-D therapy.

Efficacy of cardiac resynchronization therapy with defibrillator vs. cardiac resynchronization therapy with pacing

The use of CRT-D or CRT-P in clinical practice is an important question with significant implications in terms of costs,[2,3] as well as inappropriate device therapy,[4] and device-related complications.[5,6] Furthermore, advanced co-morbidities that are more common in the older age groups[1] may attenuate the survival benefit of ICD therapy.[7]

All available cost-effectiveness estimates for CRT have been based on the results of randomized trials of selected patient populations with relatively short follow-up. Using a lifetime time horizon and comparison with optimal medical therapy, the cost-effectiveness values for both CRT-P and CRT-D appear to be in line with benchmark of $50 000/QUALY, commonly used within threshold values in USA, Europe and WHO for many developed regions in the world.[2] Thus, clinical judgment of the patient's profile in the context of current evidence may provide the basis of choosing between the devices. Since no direct comparisons of the relative cost-effectiveness of these two approaches are available, the assessment is mainly based on projections of available short-term follow-up data, or on mathematical modelling. For example, Fox *et al.*[3] have shown that when both CRT-P and CRT-D were considered as competing technologies with each other and optimal pharmacological therapy (three-way probabilistic analysis), and at the same willingness-to-pay threshold, there was a 68% probability that CRT-P provided the highest expected net benefit.

Recent analysis from the MADIT-CRT trial showed that risk of ventricular arrhythmias was significantly reduced in CRT patients with normalization of EF; however, the risk of inappropriate ICD therapy was unchanged, suggesting that these patients may do better by a downgrade to CRT-P at device change.[4] Thus, by inducing favourable remodelling of the LV, CRT may reduce the substrate for ventricular arrhythmias.

A few studies have attempted to directly compare outcomes between CRT-P vs. CRT-D patients.[16–18] The only randomized trial to have CRT-P and CRT-D arms—the COMPANION trial[19]—did not show a significant benefit of CRT-D over CRT-P for the primary endpoint. However, the study was not powered to compare these two treatments. Non-randomized studies that compared outcomes of these two treatment options have yielded conflicting results,[5,16–18] and a Bayesian network meta-analysis concluded that evidence from randomized trials is insufficient to prove the superiority of CRT-D over CRT-P.[20]

The CeRtiTuDe multicentre prospective cohort study[11] found that when compared to CRT-D patients, at 2 years, excess mortality in CRT-P recipients was mainly due to non-sudden cardiac death, suggesting that CRT-P patients, as currently selected in routine clinical practice, would not potentially benefit from the addition of a defibrillator. Similar to our findings and those of other groups,[16] they demonstrated that CRT-P patients, as chosen in routine clinical practice, were older, more likely to be female, with less ischaemic heart disease and more advanced HF. The rates of HF hospitalization were greater in the CRT-P group, which is in line with the greater HF mortality in this group. This was probably related to a sicker population with more co-morbidity, older age, and potentially more severe HF.

When comparing CRT-D and CRT-P in the older vs. younger population: a single-centre retrospective small study focusing on the octogenarian patients who received CRT with or without defibrillator has shown that octogenarian patients had improvement in HF symptoms and LV systolic function comparable to the younger patients, with similar procedural complication rates; advanced age was not an independent factor for decreased survival after CRT-D implantation.[18]

Our findings extend prior data by directly comparing CRT-P vs. CRT-D in octogenarians using prospective real-world data. We showed that CRT-D does not have a survival benefit over CRT-P or a benefit for the combined endpoint of survival and hospitalizations for HF in the population ≥80 years of age.

Efficacy of implantable cardioverter defibrillator in elderly patients

The prevalence of HF and the mortality associated with HF increases directly with age.[15] There is a controversy whether ICD is associated with an attenuated or even lack of clinical benefit in older patients with systolic HF compared with young patients: in two analyses of the MADIT-II trial, compared with conventional therapy, ICD was associated with a reduction in all-cause mortality in older patients (≥75 years) compared with younger ones.[1,8] However, in a meta-analysis including five primary prevention ICD trials,[10] ICD therapy in older patients was not associated with a significant reduction in mortality.

Current guidelines[21] suggest that age is not among the criteria considered for appropriate use of ICD and that the decision to implant an ICD in the elderly should consider the consequences of the device on quality of life.[17]

Older patients and patients with major comorbidities have been excluded from major ICD trials.[1] Thus, data on the efficacy of ICD in elderly patients are limited and come primarily from observational retrospective studies and subgroup analysis of randomized trials. Results of these studies were inconsistent because the definition of 'elderly', as well as the medical treatment, was varied.

The MADIT-II[9] and MUSTT[22] investigators developed a risk prediction model in which advanced age was shown to be one of the risk factors improving the benefit of ICD. However, in prospective registries of primary and secondary prevention ICD recipients, it was found that whereas elderly patients exhibited increased mortality after ICD implantation, rates of appropriate device shocks were similar across age groups.[23] A meta-analysis combining data from trials on primary prevention of sudden cardiac death (SCD)[24] found that ICD therapy reduced all-cause mortality in patients ≥75 years of age in the absence of ICD-related complications.

However, a different analysis suggested that ICD therapy might be less beneficial in elderly patients with severe LV dysfunction.[12] Similarly, pooled data from secondary prevention trials revealed that ICD therapy significantly reduced all-cause and arrhythmic death in patients ≤75 years old, but not in patients >75 years.[25] In addition, in a MADIT-II sub-study, no significant decrease in quality-adjusted life-years for patients ≥65 years was established with ICD.[26]

Efficacy of cardiac resynchronization therapy with defibrillator in elderly patients

The MADIT-CRT Trial[27] showed that during an average follow-up of 2.4 years, CRT-D decreased the risk of HF events in relatively asymptomatic patients with a low EF and wide QRS complex. The superiority of CRT-D over ICD alone in the primary endpoint (death from any cause or a nonfatal HF event) was driven by a 41% reduction in the risk of HF events (primarily when QRS > 150 ms). There was no significant difference in the overall risk of death. These effects were preserved for patients ≥75 years, with no significant increase in the rate of device-related adverse events vs. younger ones.[28]

Based on recent real-world data of elderly patients (>75 years) enrolled in the Israeli ICD Registry,[23] we have shown that elderly patients implanted with CRT-D experienced a significant reduction in the risk for HF, arrhythmic events, and mortality events to a level similar to that experienced by their younger counterparts, whereas this effect was not shown among old patients who received ICD-only therapy. Similarly, the CARE-HF trial showed that in patients with moderate to severe HF and cardiac dyssynchrony, CRT without a defibrillator reduces the risk of death, during a mean follow-up of 29.4 months.[29]

Heidenreich *et al.*[30] showed that 39% of CRT-Ds in the United States were implanted in patients ≥75 years, and that compared to ICD only, CRT-D was associated with better survival at 1 and 4 years of follow-up across all age groups. Another sub-study of the MADIT-CRT trial further showed that in patients with LBBB and mild HF symptoms, aging is associated with a significant decrease in the incidence of ventricular tachyarrhythmias and appropriate ICD shocks.[12] These data support our findings and suggest that CRT-P may confer similar benefit to CRT-D in older patients.[13]

Limitations

Our study has several limitations. First, Kaplan–Meier analysis showed a trend towards higher mortality rate in the CRT-D group, despite the fact that this group was younger than the CRT-P group. However, this difference was not statistically significant, most probably due to the small size of the study population.

Second, we compared two different cohorts—patients implanted with CRT-P in a single centre vs. patients implanted with CRT-D in 22 centres that were included in a national registry. The difference in the characteristics of the patient groups and in the intensity and mode of follow-up could have affected the results of rates and causes of hospitalizations.

Third, the two groups were significantly different regarding percentage of patients upgraded from pacemakers. Continuous RV pacing may deteriorate the LV function and NYHA class, and it is well known that these patients benefit from CRT. Thus, both groups may not be fully comparable. However, the percentage of patients with pacing dependency was not statistically different between the groups, thus we believe that outcomes of these cohorts can be compared.

Fourth, the limited number of HF events reduced our ability to evaluate difference in HF hospitalizations as a separate endpoint.

Conclusions

In a real-world scenario, outcomes of octogenarians implanted with CRT-P are similar to those implanted with CRT-D regarding rates of mortality and the combination of HF and death. These findings suggest that, in older patients, implantation of CRT-P alone, without defibrillator therapy, may be considered as an alternative to CRT-D. The presented data question the appropriateness and applicability of current guidelines for ICD back-up in elderly patients with HF. Future prospective studies and larger study groups are needed to confirm our findings.

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