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Amiodarone or an Implantable Cardioverter–Defibrillator for Congestive Heart Failure

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ABSTRACT

BACKGROUND

Sudden death from cardiac causes remains a leading cause of death among patients with congestive heart failure (CHF). Treatment with amiodarone or an implantable cardioverter–defibrillator (ICD) has been proposed to improve the prognosis in such patients.

METHODS

We randomly assigned 2521 patients with New York Heart Association (NYHA) class II or III CHF and a left ventricular ejection fraction (LVEF) of 35 percent or less to conventional therapy for CHF plus placebo (847 patients), conventional therapy plus amiodarone (845 patients), or conventional therapy plus a conservatively programmed, shock-only, single-lead ICD (829 patients). Placebo and amiodarone were administered in a double-blind fashion. The primary end point was death from any cause.

RESULTS

The median LVEF in patients was 25 percent; 70 percent were in NYHA class II, and 30 percent were in class III CHF. The cause of CHF was ischemic in 52 percent and nonischemic in 48 percent. The median follow-up was 45.5 months. There were 244 deaths (29 percent) in the placebo group, 240 (28 percent) in the amiodarone group, and 182 (22 percent) in the ICD group. As compared with placebo, amiodarone was associated with a similar risk of death (hazard ratio, 1.06; 97.5 percent confidence interval, 0.86 to 1.30; P=0.53) and ICD therapy was associated with a decreased risk of death of 23 percent (0.77; 97.5 percent confidence interval, 0.62 to 0.96; P=0.007) and an absolute decrease in mortality of 7.2 percentage points after five years in the overall population. Results did not vary according to either ischemic or nonischemic causes of CHF, but they did vary according to the NYHA class.

CONCLUSIONS

In patients with NYHA class II or III CHF and LVEF of 35 percent or less, amiodarone has no favorable effect on survival, whereas single-lead, shock-only ICD therapy reduces overall mortality by 23 percent.

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PATIENTS WITH CONGESTIVE HEART FAILURE (CHF) can die suddenly and unpredictably from arrhythmia despite the use of proven medical therapies, such as beta-blockade. Two approaches have been developed specifically to prevent sudden death among patients with CHF: therapy with amiodarone and therapy with an implantable cardioverter–defibrillator (ICD). Despite findings in earlier clinical trials, the ability of amiodarone to reduce the risk of death among patients with CHF remains uncertain.[1,2] The ability of an ICD to limit mortality in patients with CHF without prior cardiac arrest has been evaluated in small trials focused on patients with nonischemic cardiomyopathy[3,4] and also remains unproven. Most of the mortality data on amiodarone and ICD therapy have been obtained in clinical trials performed after myocardial infarction in patients without CHF or those with ventricular arrhythmias.[5-10] Such data have not been judged sufficiently relevant to guide therapy for patients who do not meet these criteria.

The Sudden Cardiac Death in Heart Failure Trial (SCD-HeFT)[11] was designed to evaluate the hypothesis that amiodarone or a conservatively programmed shock-only, single-lead ICD would decrease the risk of death from any cause in a broad population of patients with mild-to-moderate heart failure.

METHODS

STUDY DESIGN

From September 16, 1997, to July 18, 2001, we randomly assigned 2521 patients in equal proportions to receive placebo, amiodarone (Cordarone, Wyeth–Ayerst Pharmaceuticals), or a single-chamber ICD programmed to shock-only mode (model 7223, Medtronic). All patients were followed until October 31, 2003. Patients had to be at least 18 years of age and have New York Heart Association (NYHA) class II or III chronic, stable CHF due to ischemic or nonischemic causes and a left ventricular ejection fraction (LVEF) of no more than 35 percent. Ischemic CHF was defined as left ventricular systolic dysfunction associated with at least 75 percent narrowing of at least one of the three major coronary arteries (marked stenosis) or a documented history of a myocardial infarction. Nonischemic CHF was defined as left ventricular systolic dysfunction without marked stenosis.

The primary end point of the trial was death from any cause. The study was approved by the human-subjects' committee of each participating institution. Sponsorship and oversight of the trial were by the National Heart, Lung, and Blood Institute (NHLBI). The trial was funded after peer review. An NHLBI-appointed data-monitoring and safety-monitoring board oversaw the conduct of the trial. Every patient provided written informed consent. A detailed review of SCD-HeFT methods has been published previously.[11] Study drugs and ICDs were provided free of charge by the manufacturers (Wyeth–Ayerst and Medtronic, respectively). Additional clinical and research funding was also provided by these companies. Neither company had any role in the design, analysis, or interpretation of the study.

BASELINE ASSESSMENTS AND BACKGROUND MEDICAL THERAPIES

Before randomization, all patients underwent electrocardiography, a 6-minute walk test, 24-hour ambulatory electrocardiography, liver- and thyroid-function studies, and chest radiography. All patients were required, if such treatment was clinically reasonable, to receive treatment with a beta-blocker and an angiotensin-converting–enzyme inhibitor, as well as aldosterone, aspirin, and statins, when appropriate.

STUDY DRUG

Placebo and amiodarone were administered in a double-blind fashion with the use of identical-appearing 200-mg tablets produced by Wyeth–Ayerst Pharmaceuticals. The dose was based partly on weight. After a loading dose of 800 mg daily was given for one week and 400 mg daily for three weeks, patients weighing more than 200 lb (90.9 kg) received 400 mg daily, patients weighing 150 to 200 lb (68.2 to 90.9 kg) received 300 mg daily, and patients weighing less than 150 lb (68.2 kg) received 200 mg daily. Physicians could lower the loading or maintenance dose if a patient had bradycardia.

ICD THERAPY

ICD therapy was intentionally selected to consist of shock-only, single-lead therapy. The goal was to treat only rapid, sustained ventricular tachycardia or ventricular fibrillation. No dual-chamber or biventricular devices were permitted. The ICD was uniformly programmed to have a detection rate of 187 beats per minute or more. To minimize excessively rapid intervention in the event of nonsustained ventricular tachycardia, antitachycardia pacing therapies were not permitted, given the unknown fre-

quency of sustained ventricular tachycardia or fibrillation in the population at the time. Because of the potential for the acceleration of ventricular tachycardia and the resulting increased sensitivity to transient ventricular tachycardia, the use of antitachycardia pacing was considered to pose more risk than benefit. Because of the potential for antibradycardia pacing to worsen CHF, it was initiated only if the intrinsic rate decreased to less than 34 beats per minute, the lowest trigger limit possible in the ICD model (Medtronic model 7223) used. No rate-responsive pacing was allowed.

INITIATION OF THERAPY AND FOLLOW-UP

Patients assigned to amiodarone or matching placebo began therapy as outpatients immediately after randomization. Patients assigned to ICD therapy received their device a median of three days after randomization (interquartile range, two to five). Outpatient implantation of the device was encouraged. ICD testing could not exceed two inductions of ventricular fibrillation. If an initial 20-J shock terminated induced ventricular fibrillation (as occurred 84 percent of the time), a 10-J shock was tested and no further inductions were recommended. If the 20-J shock was unsuccessful, a 30-J shock was administered at the next induction. If both 20-J and 30-J shocks were unsuccessful, no further testing or lead configurations were recommended. The device was to be inserted without further delay given the risk associated with a prolonged procedure, the low likelihood of improving defibrillation thresholds, and the lack of a clear relation between the results of tests at implantation and long-term efficacy. Patients were followed every three months with alternating clinic visits and telephone calls. Data from the ICD memory log were regularly downloaded at these visits. Some patients may have had ICD discharges that were either not recorded or not reported to the ICD core laboratory, thus limiting our ability to know the true rate of ICD events.

STATISTICAL ANALYSIS

The study was based on the assumption that the placebo group would have an annual mortality rate of 10 percent. The study was powered at 90 percent to detect a 25 percent reduction in death from any cause by amiodarone or ICD therapy, as compared with placebo, on the basis of an α level for each comparison of 0.025. Permuted-block randomization with stratification according to the clinical site, the cause of CHF (ischemic vs. nonischemic), and NYHA class (II vs. III) was used, with block size randomly chosen to be either three or six.

Pairwise comparisons of amiodarone with placebo and ICD with placebo were performed according to the intention-to-treat principle. All statistical tests were two-tailed. Cumulative mortality rates were calculated according to the Kaplan–Meier method.[12] Event (or censoring) times for all patients were measured from the time of randomization (time zero). The significance of differences in mortality rates between treatment groups was assessed with the log-rank test, with adjustment for the NYHA class and the cause of CHF.[13] Relative risks were expressed as hazard ratios with associated confidence intervals and were derived from the Cox proportional-hazards model.[14] Consistent with the choice of an α value of 0.025 for the two main treatment comparisons, 97.5 percent confidence intervals are reported for the hazard ratios. The Cox model was also used to test the significance of interactions between the NYHA class and treatment and between the cause of CHF and treatment.

Six interim analyses of the data were performed and reviewed by the independent data and safety monitoring board appointed by the NHLBI. Interim treatment comparisons were monitored with the use of two-sided, symmetric O'Brien–Fleming boundaries generated with the Lan–DeMets alpha-spending-function approach to group-sequential testing.[15,16] Because of the sequential monitoring, the level of significance required for each major treatment comparison at the completion of the study was 0.023.

RESULTS

STUDY POPULATION

Among the 2521 patients, 847 were randomly assigned to placebo, 845 to amiodarone, and 829 to ICD therapy. Demographic and clinical data for the three treatment groups are shown in Table 1. There were no significant differences among the three groups, except in the use of beta-blockers at the time of the last follow-up visit ($P<0.001$). At baseline, the median LVEF of patients was 25 percent; 70 percent had NYHA class II CHF, and 30 percent had class III CHF. The median follow-up for all surviving patients was 45.5 months. All surviving patients were followed at least two years. The longest follow-up was 72.6 months. Vital status was known for all 2521 patients at the time of the last scheduled follow-up visit.

Table 1. Characteristics of the Patients at Baseline or at the Last Follow-up Visit.

Characteristic	Amiodarone (N=845)	Placebo (N=847)	ICD Therapy (N=829)
Age — yr			
Median	60.4	59.7	60.1
Interquartile range	51.7–68.3	51.2–67.8	51.9–69.2
Female sex — no. (%)	206 (24)	192 (23)	190 (23)
Nonwhite race — no. (%)	196 (23)	204 (24)	189 (23)
Ejection fraction			
Median	25.0	25.0	24.0
Interquartile range	20.0–30.0	20.0–30.0	19.0–30.0
Diabetes — no. (%)	243 (29)	271 (32)	253 (31)
Pulmonary disease — no. (%)	147 (17)	158 (19)	175 (21)
Hypercholesterolemia — no. (%)*	442 (52)	456 (54)	431 (52)
Hypertension — no. (%)	469 (56)	478 (56)	453 (55)
Atrial fibrillation or flutter — no. (%)	132 (16)	117 (14)	141 (17)
Nonsustained ventricular tachycardia — no. (%)†	193 (23)	180 (21)	210 (25)
Syncope — no. (%)	54 (6)	56 (7)	52 (6)
Electrophysiological study — no. (%)	148 (18)	130 (15)	129 (16)
Weight — lb‡			
Median	190	190	190
Interquartile range	164–216	163–221	163–220
Systolic blood pressure — mm Hg			
Median	118	120	118
Interquartile range	106–130	108–132	104–131
Diastolic blood pressure — mm Hg			
Median	70	70	70
Interquartile range	62–80	62–80	61–80
Heart rate — beats/min			
Median	72	73	74
Interquartile range	64–82	64–84	65–84
Serum sodium — mEq/liter			
Median	139	139	139
Interquartile range	137–141	137–141	137–141
Serum creatinine — mg/dl§			
Median	1.1	1.1	1.1
Interquartile range	0.9–1.3	0.9–1.4	0.9–1.4

COMPLIANCE AND CROSSOVERS

The median dose of amiodarone and placebo was 300 mg per day three months after randomization and remained so throughout the study. The noncompliance rate for study-drug therapy, defined as the discontinuation of either placebo or amiodarone for any period, was 27 percent (458 patients). Placebo was discontinued in 189 of 847 patients (22 percent), and amiodarone was discontinued in 269 of 845 patients (32 percent). At the time of the last follow-up visit, the only complications observed in the amiodarone group, as compared with the placebo group, were increased tremor (4 percent; P=0.02) and increased hypothyroidism (6 percent; P<0.001).

Table 1. (Continued.)

Characteristic	Amiodarone (N=845)	Placebo (N=847)	ICD Therapy (N=829)
Medication use — no. (%)¶			
ACE inhibitor at enrollment	731 (87)	718 (85)	684 (83)
ACE inhibitor at last follow-up	594 (71)	619 (74)	576 (70)
ARB at enrollment	118 (14)	132 (16)	114 (14)
ARB at last follow-up	152 (18)	145 (17)	144 (18)
ACE inhibitor or ARB at enrollment	822 (97)	827 (98)	783 (94)
ACE inhibitor or ARB at last follow-up	718 (85)	740 (88)	706 (86)
Beta-blocker at enrollment	581 (69)	581 (69)	576 (69)
Beta-blocker at last follow-up‖	605 (72)	662 (79)	672 (82)
Diuretic			
Loop at enrollment	696 (82)	692 (82)	676 (82)
Loop at last follow-up	665 (79)	674 (80)	649 (79)
Potassium-sparing at enrollment	174 (21)	165 (19)	168 (20)
Potassium-sparing at last follow-up	236 (28)	278 (33)	261 (32)
Thiazide at enrollment	52 (6)	60 (7)	63 (8)
Thiazide at last follow-up	95 (11)	88 (11)	80 (10)
Digoxin at enrollment	614 (73)	589 (70)	552 (67)
Digoxin at last follow-up	496 (59)	524 (62)	512 (63)
Aspirin at enrollment	461 (55)	477 (56)	477 (58)
Aspirin at last follow-up	474 (56)	451 (54)	449 (55)
Warfarin at enrollment	310 (37)	281 (33)	266 (32)
Warfarin at last follow-up	272 (32)	300 (36)	279 (34)
Statin at enrollment	334 (40)	319 (38)	312 (38)
Statin at last follow-up	405 (48)	387 (46)	395 (48)

* Hypercholesterolemia was defined as a low-density lipoprotein cholesterol level at enrollment of more than 130 mg per deciliter (3.4 mmol per liter) after an overnight fast.
† Nonsustained ventricular tachycardia was defined as 3 or more consecutive ventricular beats at a heart rate of more than 100 beats per minute.
‡ To convert weight to kilograms, divide by 2.2.
§ To convert values for creatinine to micromoles per liter, multiply by 88.4.
¶ Data for follow-up medication were available for 2500 patients (amiodarone, 840; placebo, 838; and ICD, 822). ACE denotes angiotensin-converting enzyme, and ARB angiotensin II–receptor blocker.
‖ P<0.001 for the comparison among the groups.

A total of 125 patients (7 percent) in the drug groups crossed over to open-label treatment with amiodarone at some point, including 44 in the amiodarone group and 81 in the placebo group. Among the 829 patients in the ICD group, 113 (14 percent) received open-label amiodarone during some part of follow-up.

Of the 829 patients assigned to ICD therapy, 17 (2 percent) declined to undergo implantation and implantation was unsuccessful in 1 (less than 1 percent). An additional 32 patients (4 percent) had their ICD removed during follow-up. Clinically significant ICD complications, defined as clinical events requiring surgical correction, hospitalization, or new and otherwise unanticipated drug therapy, occurred in 5 percent of the patients at the time of implantation and in 9 percent later in the course of the trial. Defibrillation-testing data were reported in 716 patients. None of these patients required more than a 30-J shock for defibrillation, the maximal device output.

Crossover to some form of ICD therapy during

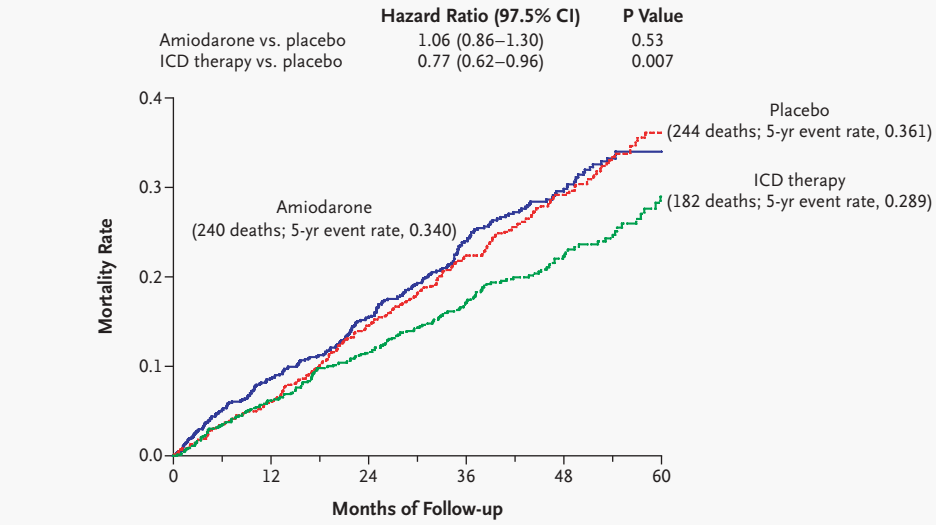


Figure 1. Kaplan–Meier Estimates of Death from Any Cause.
CI denotes confidence interval.

follow-up occurred in 188 patients (11 percent) in the drug groups. The median time from randomization to crossover was 26.7 months.

ICD SHOCKS

Of the 829 patients in the ICD group, 259 (31 percent) were known to have received shocks from their device for any cause, with 177 (68 percent of those shocked, or 21 percent of the ICD group) receiving shocks for rapid ventricular tachycardia or fibrillation. During five years of follow-up, the average annual rate of ICD shocks was 7.5 percent. For appropriate shocks only (i.e., shocks for rapid, sustained ventricular tachycardia or fibrillation), the average annual rate of ICD shocks was 5.1 percent.

PRIMARY OUTCOME

A total of 666 patients died: 244 (29 percent) in the placebo group, 240 (28 percent) in the amiodarone group, and 182 (22 percent) in the ICD group. As compared with placebo, amiodarone therapy was associated with a similar risk of death (hazard ratio, 1.06; 97.5 percent confidence interval, 0.86 to 1.30; P=0.53) and ICD therapy was associated with a decreased risk of death (hazard ratio, 0.77; 97.5 percent confidence interval, 0.62 to 0.96; P=0.007). Kaplan–Meier mortality curves are shown in Figure 1. The relative risk reduction of ICD therapy as compared with placebo was 23 percent, and the absolute reduction at five years was 7.2 percentage points.

PRESPECIFIED SUBGROUPS

Mortality curves and hazard ratios for the comparison of placebo with amiodarone and with ICD therapy according to the prespecified subgroups defined by the cause of CHF and NYHA class are shown in Figures 2 and 3, respectively. There was no interaction of either amiodarone therapy (P=0.93) or ICD therapy (P=0.68) with the cause of CHF. The interaction between amiodarone and NYHA class was significant (P=0.004). Among patients with NYHA class III CHF, there was a relative 44 percent increase in the risk of death among patients in the amiodarone group, as compared with those in the placebo group (hazard ratio, 1.44; 97.5 percent confidence interval, 1.05 to 1.97). Among patients with NYHA class II CHF, no excess risk of death was associated with amiodarone therapy, as compared with placebo (hazard ratio, 0.85; 97.5 percent confidence interval, 0.65 to 1.11).

The interaction between ICD therapy and NYHA class was also significant (P<0.001). Among pa-

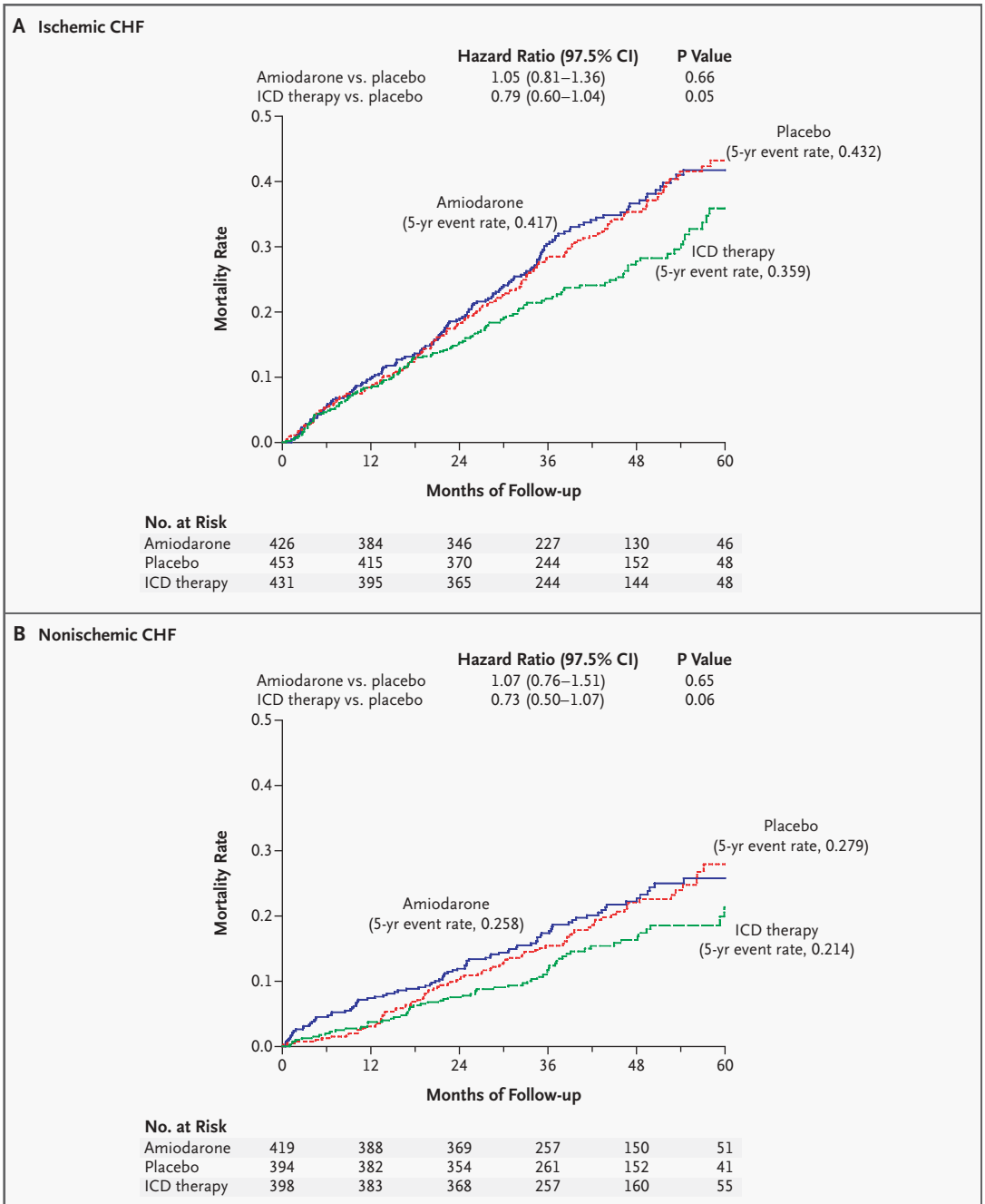


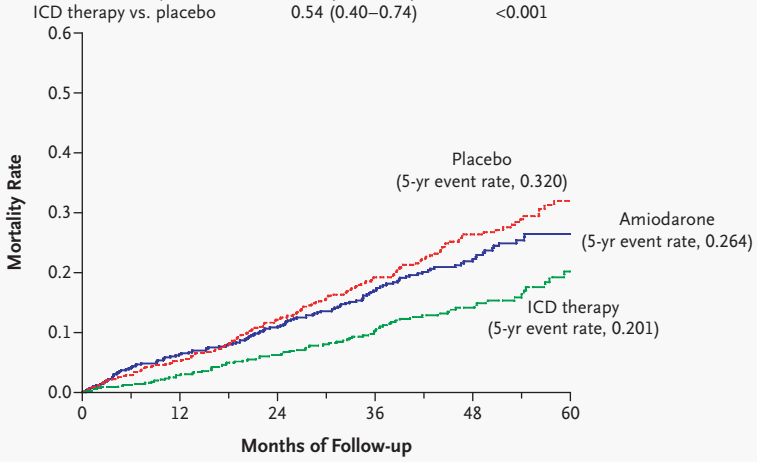
Figure 2. Kaplan–Meier Estimates of Death from Any Cause for the Prespecified Subgroups of Ischemic CHF (Panel A) and Nonischemic CHF (Panel B).

CI denotes confidence interval.

tients with NYHA class II CHF, there was a 46 percent relative reduction in the risk of death (hazard ratio, 0.54; 97.5 percent confidence interval, 0.40 to 0.74). The absolute reduction in mortality among patients in NYHA class II was 11.9 percent at five years. Patients with NYHA class III CHF had no apparent reduction in the risk of death with ICD therapy, as compared with placebo (hazard ratio, 1.16;

A NYHA Class II

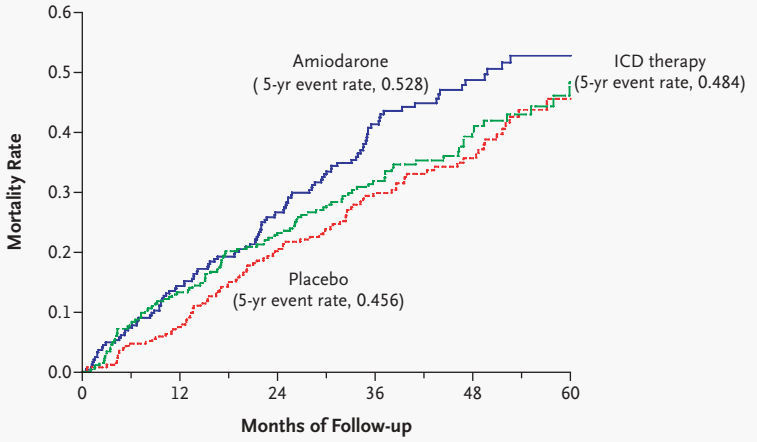
	Hazard Ratio (97.5% CI)	P Value
Amiodarone vs. placebo	0.85 (0.65–1.11)	0.17
ICD therapy vs. placebo	0.54 (0.40–0.74)	<0.001



No. at Risk						
Amiodarone	601	563	536	378	222	76
Placebo	594	563	522	367	218	72
ICD therapy	566	550	531	371	236	80

B NYHA Class III

	Hazard Ratio (97.5% CI)	P Value
Amiodarone vs. placebo	1.44 (1.05–1.97)	0.010
ICD therapy vs. placebo	1.16 (0.84–1.61)	0.30



No. at Risk						
Amiodarone	244	209	179	106	58	21
Placebo	253	234	202	138	86	17
ICD therapy	263	228	202	130	68	23

Figure 3. Kaplan–Meier Estimates of Death from Any Cause for the Prespecified Subgroups of NYHA Class II (Panel A) and Class III (Panel B).

CI denotes confidence interval.

97.5 percent confidence interval, 0.84 to 1.61). Hazard ratios for other subgroups of interest pertinent to the comparison of placebo with amiodarone and with ICD therapy are shown in Figure 4.

DISCUSSION

Our study has two principal findings. First, therapy with a conservatively programmed, shock-only ICD significantly decreased the relative risk of death by 23 percent, resulting in an absolute reduction of 7.2 percentage points at five years among patients with CHF who received state-of-the-art background medical therapy, and the benefit did not vary according to the cause of CHF. Second, amiodarone had no beneficial effect on survival, despite the use of appropriate dosage and reasonable compliance rates over longer periods than in other placebo-controlled trials.[1,9,10]

Our findings raise the standard of care for many patients with CHF by substantiating evidence from earlier trials in favor of ICD therapy in patients with ischemic CHF and by providing evidence of a survival benefit associated with such therapy in patients with nonischemic CHF. ICD therapy had a significant benefit in patients in NYHA class II but not in those in NYHA class III CHF. In contrast, amiodarone therapy had no benefit in patients in NYHA class II and decreased survival among patients in NYHA class III CHF, as compared with those who received placebo.

Subgroup effects, however, are considered most credible if they are prespecified, have a significant interaction with treatment, and are considered biologically plausible. The NYHA subgroups were prespecified, and the results of the interaction tests were significant. Moreover, the results of the six-minute walk test (Fig. 4) support the findings with respect to NYHA class, not only for ICD therapy but also for amiodarone. Nevertheless, it is worth pointing out that this subgroup effect was not anticipated before data analysis. Rather, the general trend in prior trials had been for the relative treatment effect to be nearly constant and, thus, for the treatment benefit to be larger in absolute terms for sicker patients. Whether the treatment differences that we observed in NYHA-class subgroups are biologically plausible is uncertain.

The traditional view of clinical trialists is that the results of subgroup analysis are inherently misleading and should be interpreted very conservatively until replicated elsewhere. In the absence of replication, the findings of other trials can guide the interpretation of this particular subgroup effect. In the Multicenter Automatic Defibrillator Implantation Trial II (MADIT II),[17] a study of patients who had had a myocardial infarction, and in the Antiarrhythmics versus Implantable Defibrillators (AVID) study,[6] a secondary prevention trial, the worse the ejection fraction, the greater the benefit of ICD therapy. In a post hoc analysis, MADIT II showed a benefit of ICD therapy in terms of survival that was similar to the overall trial results when the groups were stratified according to the NYHA class (I, II, or III) (MADIT II Executive Committee: personal communication). In the Defibrillators in Non-Ischemic Cardiomyopathy Treatment Evaluation (DEFINITE) trial, patients in NYHA class III derived the largest survival benefit from ICD therapy.[4] Thus, we do not believe that the unanticipated subgroup effect we found is a sufficient basis for withholding ICD therapy from patients in NYHA class III.

Another pertinent finding of our study was that single-lead ICDs proved beneficial despite a 5 percent rate of acute device-related complications and 9 percent rate of chronic complications. It is not surprising that ICD therapy has complications related to surgery and long-term management limitations, but the survival benefit associated with simple, shock-only ICD therapy outweighs any shortcomings of this approach.

Placing our findings in relation to those of other trials of ICD therapy poses some difficulties. Two previous studies have examined the role of ICD therapy in patients with CHF — the Amiodarone versus Implantable Cardioverter–Defibrillator Trial (AMIOVIRT)[3] and the DEFINITE trial[4] — but only among those with nonischemic cardiomyopathy. AMIOVIRT randomly assigned 103 patients in NYHA class I, II, or III who had an LVEF of 35 percent or less and had nonsustained ventricular tachycardia during ambulatory monitoring to amiodarone or dual-chamber ICDs programmed as VVI shock only (Strickberger A: personal communication). No mortality advantage had been observed when the trial was aborted after two years. Background use of beta-blockers was somewhat lower in AMIOVIRT than in our trial (53 percent vs. 69 percent at randomization). Differences in outcome between the two trials are probably due to differences in the number of patients enrolled and the duration of follow-up.

The DEFINITE trial randomly assigned 458 patients to ICD or standard therapy and did not find a

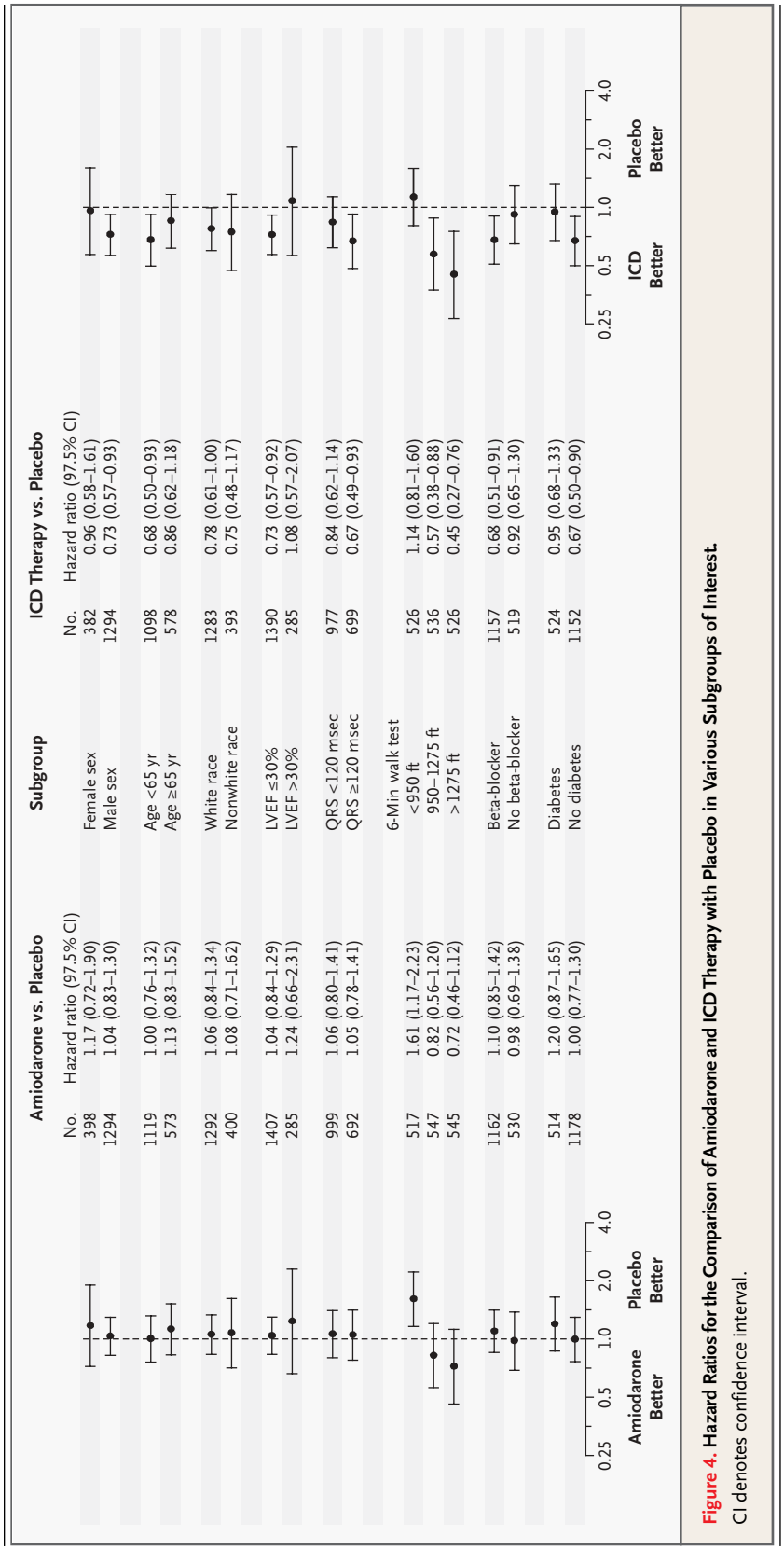


Figure 4. Hazard Ratios for the Comparison of Amiodarone and ICD Therapy with Placebo in Various Subgroups of Interest.

CI denotes confidence interval.

significant survival benefit (P=0.08). The study used nonsustained ventricular tachycardia and frequent ectopy as entry criteria, and 22 percent of the patients were in NYHA class I. In addition, the threshold for pacing was higher than in our study (40 vs. 34 beats per minute), and the heart rate prompting intervention was lower (180 vs. 187 beats per minute). Moreover, the death rate was higher at two years than among our patients with nonischemic CHF (14 percent vs. 10 percent), suggesting that there may have been fundamental differences in the two study populations.

It is critical to emphasize that the effect of ICD therapy in patients with CHF may differ substantially depending on the programming of the device; whether single-, dual-, or triple-chamber devices are used; whether antibradycardia pacing or rate-responsive pacing is used; which detection algorithm is used; and whether antitachycardia pacing maneuvers are used for ventricular tachycardia. Although physicians understand that different drugs lead to different outcomes, they may fail to realize that the same is true for ICD therapy. ICD therapy cannot be considered a single intervention, given the numerous possible permutations of this approach. Consequently, we cannot emphasize too strongly that we evaluated only very conservatively programmed ICDs with a conservative detection algorithm and shock-only therapy. We found strong evidence that this approach works; however, considerable caution should be used in extrapolating our results to other approaches to ICD therapy, such as those involving dual-chamber or biventricular pacing, since, as reported previously,[3,8,18] they may not afford the same benefit or, for that matter, any benefit.

Our findings may also be pertinent to constraining the costs of ICD therapy. ICDs were inserted on an outpatient basis, and testing of the devices was very limited. Outpatient insertion is certainly less expensive than inpatient insertion and can easily be translated to routine practice. Moreover, given the finding that no patient who underwent ICD testing required more than the maximal output of the device to terminate ventricular fibrillation, a reasonable argument can be made that defibrillation testing is unwarranted in this population. The risk and cost of defibrillation testing are likely to outweigh the remote possibility that a rare patient might benefit from it. A simplified, effective approach to the implantation of single-lead, shock-only ICDs such as ours should translate into cost savings.

In conclusion, amiodarone does not improve survival among patients with mild-to-moderate systolic CHF. Simple, shock-only ICD therapy improves survival beyond the improvement afforded by state-of-the-art drug therapy. Our approach to ICD therapy is widely applicable and should have a positive public health effect on the population of patients with CHF.

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