ICD: Science and Economics in Ischemic and Nonischemic Heart Failure

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Sudden Cardiac Deaths *Incidence and Total Events*



Myerburg Circulation 1998; 97:1514-1521



- 1013 patients who had been resuscitated from near-fatal VF or had sustained VT w/ syncope and EF < 40% were randomized to either ICD or class III antiarrhythmic drugs (primarily amiodarone or sotalol)
- Survival higher in ICD group at 1, 2 and 3 year follow-up (89.3, 81.6, 75.4) vs. drug group (82.3, 74.7, 64.1) (P<0.02)



SCD-HeFT (n=2521)

DCM ± CAD CHF x 3 months ACEI, b-blocker, ASA, statin EF ≤ 35% NYHA Class II or III 6 minute walk, Holter

R

Amiodarone

Placebo

SDC-HeFT Baseline Characteristics

	Amiodarone	Placebo	ICD
	(n=845)	(n=847)	(n=829)
Age	60	60	60
Female	24%	23%	23%
LVEF	25	25	24
AF	16%	14%	17%
NSVT	23%	21%	25%
ACE or ARB	97%	98%	94%
ß blocker	69%	69%	69%

Bardy, GH et al. N Engl J Med 2005:352:225-237





Bardy G et al.NEJM 2005; 352:3













Bardy G et al. NEJM 2005; 352:3







Bardy G et al.NEJM 2005; 352:3







Bardy G et al.NEJM 2005; 352:3



DEFINITE

Primary endpoint

 Total Mortality

 Secondary endpoint

 Arrhythmic Mortality

48 centers in US and Israel
 Timeline

 7/9/98
 1st patient randomized
 6/6/02
 458th patient randomized

Kaplan-Meier - All-Cause Mortality



Meta-Analysis

All-Cause Mortality Among Patients With NICM Randomized to ICD or CRT-D vs. Medical Therapy in Primary Prevention



Desai AS et al. JAMA 2004:292:2874-2879

Center for Medicare and Medicaid Services Coverage for Prophylactic ICD

- All Patients must be in Registry
- Patients with NIDCM
 - > 9 months
 - 3-9 months possible with HRS Registry or IDE study
 - LVEF $\leq 35 \%$
 - Class II-III CHF
- CRTD Therapy
 - LVEF $\leq 35\%$
 - QRSd>120msec
 - Class III-IV CHF



CMS coverage for CRT(D)

Class III and IV CHF
QRS duration >120 msec
Medical therapy optimized
CRT and CRTD covered
Class III SCD-HeFT
Class IV new indication



Surrogate Endpoints

Can ICD shocks in a registry serve as an endpoint to determine who benefits from ICD implantation?

Will ICD shocks over-predict device efficacy?

Arrhythmic Events & Syncope of Other Causes

	SCD/CA	Appropriate Shock	Syncope*	Total
STD	17		39	56
ICD	3**	35	21	57

* Not associated with an appropriate shock

****** Includes 2 patients with appropriate shocks

Ellenbogen, et al. Circulation 2006. 113(6): 776-782

Kaplan-Meier - Documented Arrhythmic Events



Ellenbogen, et al. Circulation 2006. 113(6): 776-782



Ellenbogen, et al. Circulation 2006. 113: 776

Cost effectiveness

- Cost
 - Cost?, charges?, price negotiation
- Quality of life
- Effectiveness of the intervention
- Time horizon
 - Can we extrapolate from trials with limited follow-up?

MLHF Mean Total Scores by Tx Group (95% CI)



Cost Effectiveness

- The Markov model incorporated adjustments for the QOL associated with age-specific current health, a history of myocardial infarction, and with implantation
- The model assumed that one year of life with left ventricular dysfunction equaled 0.88 year of optimal health on the basis on data from pervious studies.
- In our base-case analysis, we assumed that the quality of life did not change as a result of the implantation of an ICD.

Cost-Effectiveness of Prophylactic ICD, Efficacy



Cost-Effectiveness of Prophylactic Implantation of an ICD, Quality of Life



Sensitivity Analysis with Respect to the Frequency of Generator Replacement



Incremental Cost-Effectiveness of the Prophylactic Implantation of an ICD



Incremental Cost-Effectiveness Rations by Subgroups

	Undiscounted	Discounted 3%
NYHA class with interaction*		
II	\$23 231	\$29 872
III	N/A	N/A
Ischemic		
No	\$32 100	\$38 557
Yes	\$33 326	\$38 630
Gender		
Men	\$31 954	\$37 466
Women	\$34 831	\$42 318
Age, y		
≥65	\$37 180	\$43 943
<65	\$30 252	\$35 488
Ejection fraction		
≤30%	\$33 082	\$39 080
>30%	\$30 355	\$35 692
QRS		
≥120	\$33 865	\$40 140
<120	\$31 643	\$37 264

Mark, D. B. et al. Circulation 2006;114:135-142

Effect on cost-effectiveness of ICD therapy by varying the time horizon of the analysis



Mark, D. B. et al. Circulation 2006;114:135-142

Conclusions-Current ICD Use

- ICD decrease mortality when used in the primary and secondary prevention of SCD
- Many patients never receive appropriate ICD shocks. Shocks over-predict ICD benefit.
- CE ratios are borderline for some assumptions and groups
- Better risk stratification could improve clinical outcomes and CE

Risk Stratification



Left Ventricular Ejection Fraction





- Composite weighted means
- 95% confidence intervals
- Weight-fitted ROC curves
- Zero predictivity lines

False Positive Rate = 1 - Specificity

Bailey et al J Am Coll Cardiol 2001

Heart Rate Variability on Ambulatory ECG



False Positive Rate = 1 - Specificity

Kaplan-Meier mortality curves, stratified in the panel by MTWA test results (normal versus abnormal)



Bloomfield, D. M. et al. Circulation 2004:110:1885-1889

MUSTT Registry



Buxton, A. E. et al. N Engl J Med 2000:342:1937-1945

DYNAMIT



Hohnloser, S. H. et al. N Engl J Med 2004:351:2481-2488

Conclusions

- Current CMS guidelines appear to be backed by evidence base assessment of trial data (exception 9 months in NIDCM)
- Risk stratification techniques hold promise but are not yet supported by prospective studies. Withholding ICD therapy for patients with approved indications should be done on a case by case basis including risk assessment, QOL and possibly CE evaluation

Societal vs. patient obligations