When is EPS needed ?

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Guidelines for Clinical Intracardiac Electrophysiological Study

A report pf the ACC/AHA Task Force on practice guidelines developed in collaboration with the NASPE

1995

1. Class I

   General agreement that the EPS provides information that is useful and important for patient treatment
2. Class II

   Frequently performed, but less certainty about the usefulness of information
3. Class III

   General agreement that the EPS do not provide useful information

Role of EPS in Evaluating Sinus Node Function

Class I

1. Symptomatic patients in whom sinus node dysfunction is suspected as the cause of symptoms but **a causal relation between an arrhythmia and the symptoms** has not been established after appropriate evaluation

Class II

1. Evaluation of A-V or ventriculoatrial(VA) conduction or susceptibility to arrhythmias may aid in selection of the **most appropriate pacing modality**
2. If abnormalities are due to **intrinsic disease, autonomic nervous system dysfunction, or the effects of drugs** so as to help select therapeutic options
3. To evaluate **potential for other arrhythmias** as the cause of symptoms

Role of EPS in patients With Acquired Atrio-Ventricular Block

Class I

1. Symptomatic patients in whom **His-Purkinje block,** suspected as a cause of symptoms, has **not been established**
2. Patients with **2nd-or 3rd-degree AV block treated with a pacemaker who remain symptomatic** and in whom **another arrhythmia is suspected** as a cause of symptoms

Class II

1. Patients with 2nd- or 3rd-degree AV block in whom knowledge of the site of block or its mechanism or response to pharmacological or other temporary intervention may help direct therapy or assess prognosis
2. Patients with premature, concealed junctional depolarizations suspected as a cause of 2nd-or 3rd-degree AV block pattern (ie, pseudo AV block)

Role of EPS in patients With Chronic Intraventricular Conduction Delay

Class I

1. Symptomatic patients in whom the **cause of symptoms is not known**

Class II

1. Asymptomatic patients with BBB in whom pharmacological therapy that could increases conduction delay or produce heart block is contemplated

Role of EPS in Diagnosis of patients With Narrow QRS Complex Tachycardias

Class I

1. Patients with frequent or poorly tolerated episodes of tachycardia that do not adequately respond to drug therapy and for whom **information about site of origin, mechanism, and electrophysiological properties of pathway** of the tachycardia is essential for choosing appropriate therapy
2. Patients who **prefer ablative therapy to** pharmacological treatment

Recommendations for Radiofrequency Catheter Ablation for Atrioventricular Nodal Reentrant Tachycardia

Recommendations for Radiofrequency Catheter Ablation of Atrial Tachycardia, Flutter, and Fibrillation

Recommendations for Radiofrequency Catheter Ablation of Accessory Pathways.

Role of EPS in Diagnosis of patients with Wide QRS complex tachycardias

Class I

1. Patients with wide QRS complex tachycardia in whom **correct diagnosis is unclear** after analysis of available ECVG tracings and for whom knowledge of the correct diagnosis is necessary for patient care

Class II

Role of EPS in patients With Wolff-Parkinson-White Syndrome

Class I

1. Patients being evaluated **for catheter ablation or surgical ablation** of an accessory pathway
2. Patients with ventricular preexcitation who have **survived cardiac arrest or who have unexplained syncope**
3. Symptomatic patients in whom determination of the **mechanism of arrhythmia or knowledge of the electrophysiological properties of the accessory pathway and normal conduction system** would help in determining appropriate therapy

Class II

1. **Asymptomatic** patients with a **family history of SCD** or with ventricular preexcitation but no spontaneous arrhythmia who **engage in high-risk occupations or activities** and in whom knowledge of the electrophysiological properties of the accessory pathway or inducible tachycardia
2. Patients who are undergoing **cardiac surgery for other reasons**

Role of EPS in patients With PVCs, Couplets, and Non-sustained Ventricular Tachycardia

Class I None

Class II

1. **Patients with other risk factors for future arrhythmic events**, such as a low EF, positive SAECG, and NSVT on ambulatory ECG recordings in whom EPS will be used for further risk assessment and for guiding therapy in patients with inducible VT
2. Patients with highly symptomatic, uniform morphology PVCs, couplets, and NSVT who are considered **potential candidates or catheter ablation**

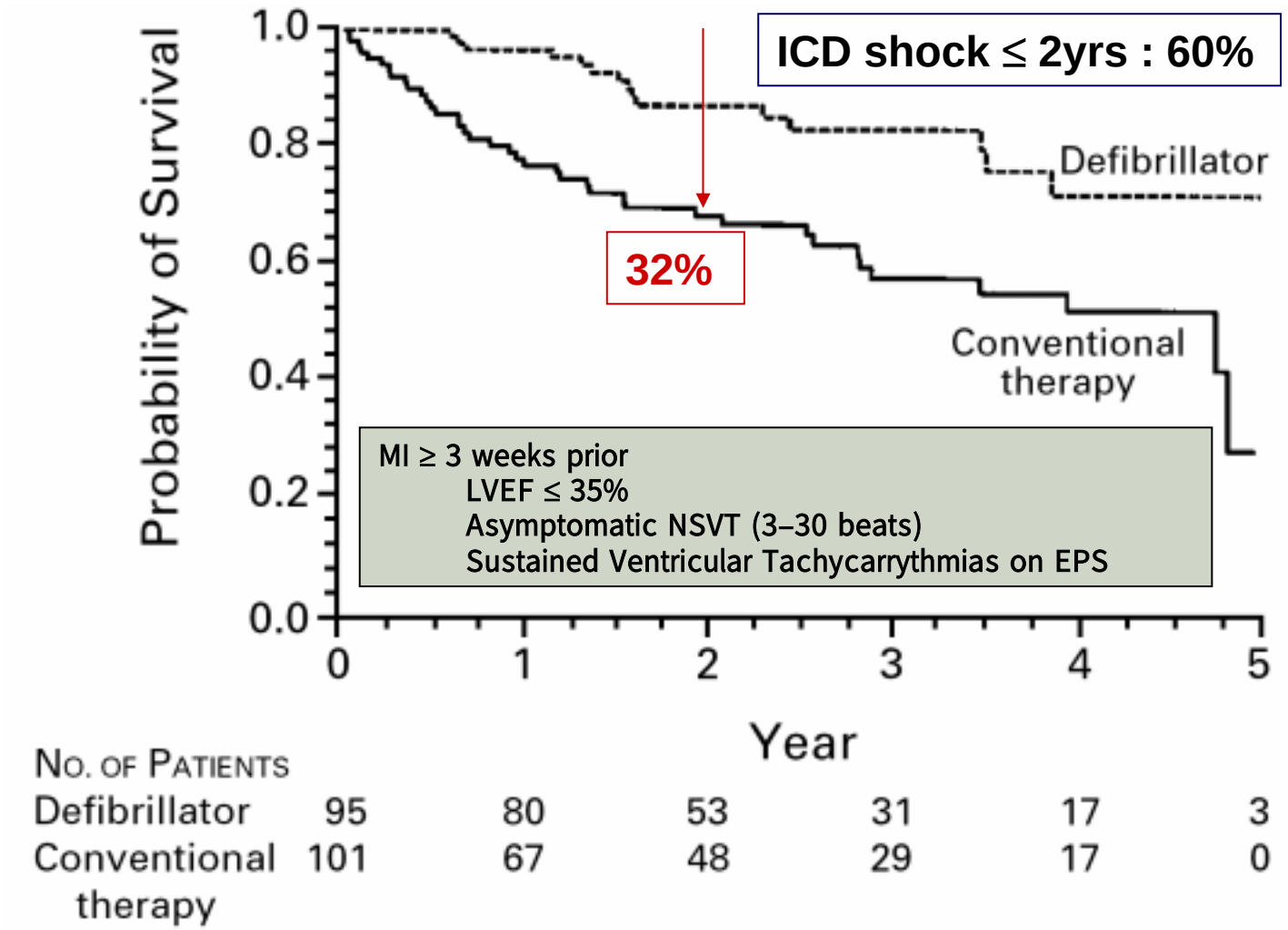
Nonsustained Ventricular Tachycardias in CAD

	MUSTT (n = 704)	MADIT (n = 196)
Mean time (MI to enrollment) (mo)	39	27
Percentage of prior CABG or PTCA	66	71
LVEF (mean)	0.30	0.26
VT-NS (mean beats)	5	9
Percentage of β blockers at discharge	40	18
CHF II–III (% patients)	64%	65%

CABG = coronary artery bypass grafting; CHF = congestive heart failure; LVEF = left ventricular ejection fraction; PTCA = percutaneous transluminal coronary angioplasty.

THE MULTICENTER AUTOMATIC DEFIBRILLATOR IMPLANTATION TRIAL,(MADIT) Survival

Mortality Rate of Conventional Group & ICD shock



Moss, et al. *New Engl J Med.* 1996; 335:1933-40.

A RANDOMIZED STUDY OF THE PREVENTION OF SUDDEN DEATH IN PATIENTS WITH CORONARY ARTERY DISEASE(MUSTT)

- **Hypothesis**
  - " **Electrophysiologically Guided Antiarrhythmic Therapy would reduce the risk of sudden death among patients with CAD, a LVEF of 40 % or less, and asymptomatic, unsustained ventricular tachycardia**."

- 2,202 patients

  from Nov.1, 1990, to October 31, 1996.

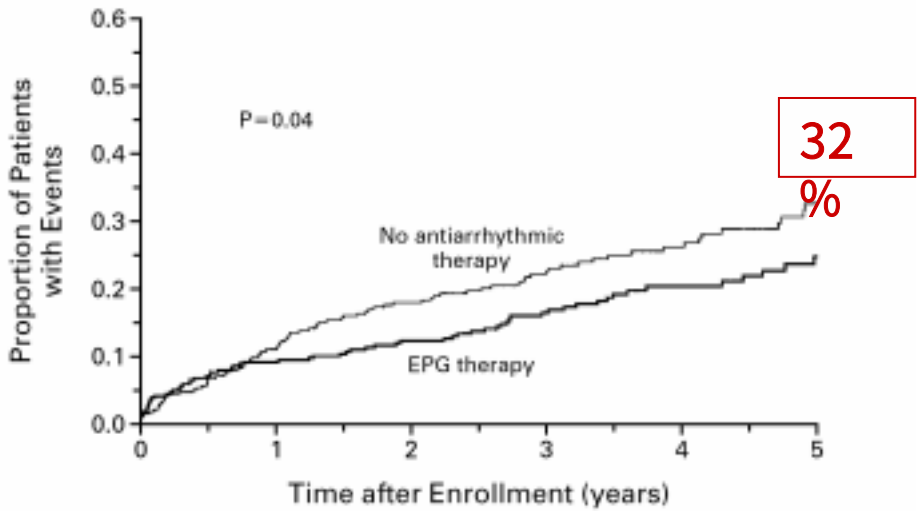
- Inducible, sustained VT

  767 (34.8%) Pts

  351 EP guided therapy : 353 No antiarrhythmic therapy

N Engl J Med 1999;341:1882-90

Five-Year Estimates of the Incidence of Cardiac Arrest or Death from Arrhythmia



No. at Risk						
No antiarrhythmic therapy	353	290	242	178	118	67
EPG therapy	351	301	265	199	119	68

Randomized Groups	**24 Months**	**60 Months**
No antiarrhythmic therapy	18%	32%
EP-guided therapy (AA Rx or ICD)	12%	25%
Subgroup		
EP-guided therapy (ICD group only)	3%	9%

N Engl J Med 1999;341:1882-90

MADIT & MUSTT

Use of Electrophysiologic Testing

1. **Enhanced the process of stratification for arrhythmia**

2. Helped select a population at particularly high risk that benefited from the defibrillator.

Role of EPS in Pts with PVCs, Couplets, and NSVT

Class I

1. Pts with CAD having risk factors for future arrhythmic events, such as low ejection fraction, positive signal averaged ECG, and NSVT on ambulatory ECG
2. Pts with highly symptomatic, amenable to catheter ablation

Class II

Role of EPS in Pts with Unexplained Syncope

Class I

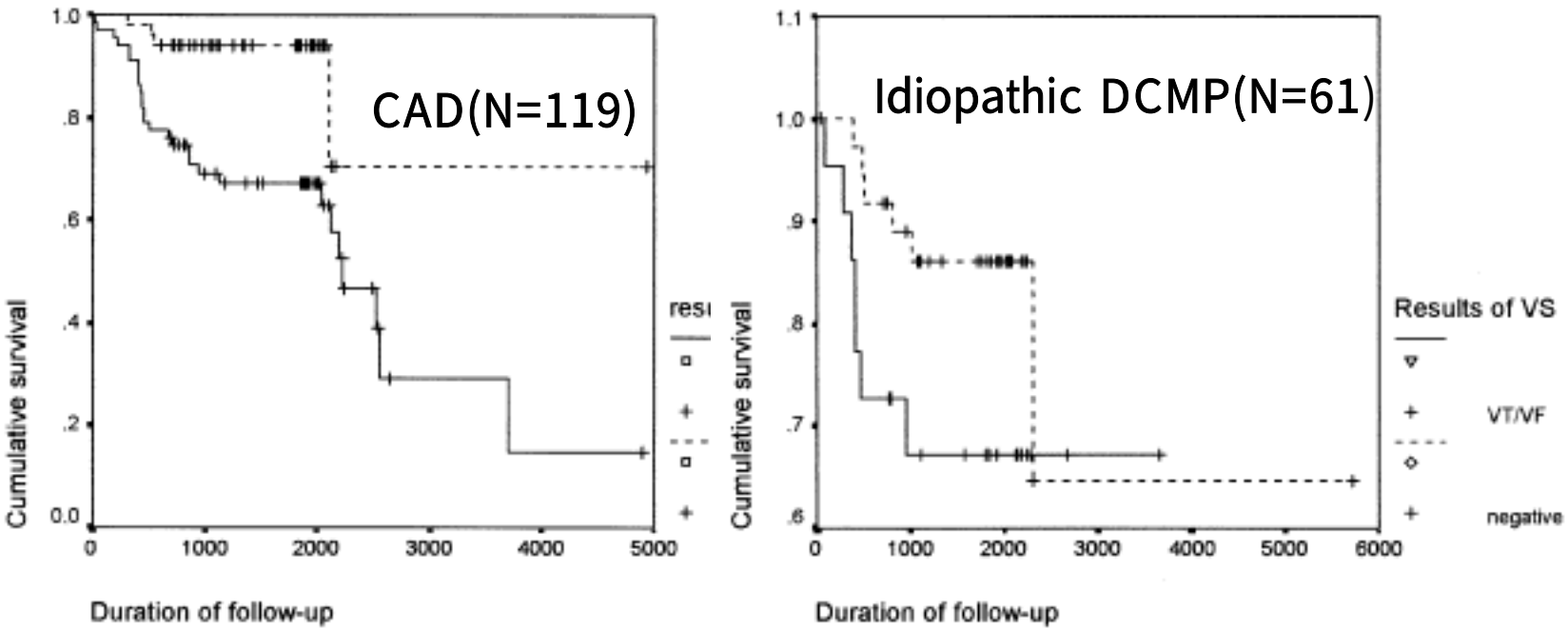
Pts with suspected structural heart disease and syncope that ramains unexplained after appropriate evaluation

Class II

Pts with recurrent unexplained syncope **without structural heart disease** and negative head-up tilt test

Differences in Mechanisms and Outcomes of Syncope in Patients With CAD or idiopathic LV dysfunction Assessed by EPS

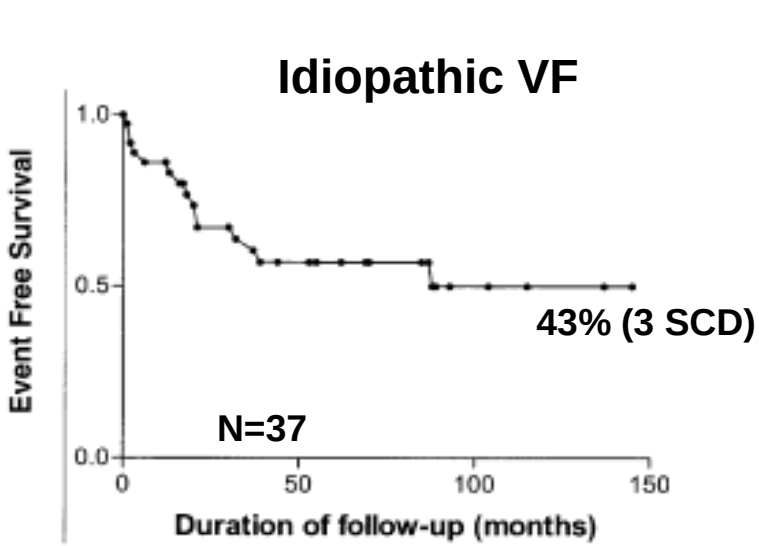
	+	VT	VF
CAD(n=119)	68	44 (37%)	24 (19%)
I-DCMP(n=61)	22	13 (21%)	9 (15%)



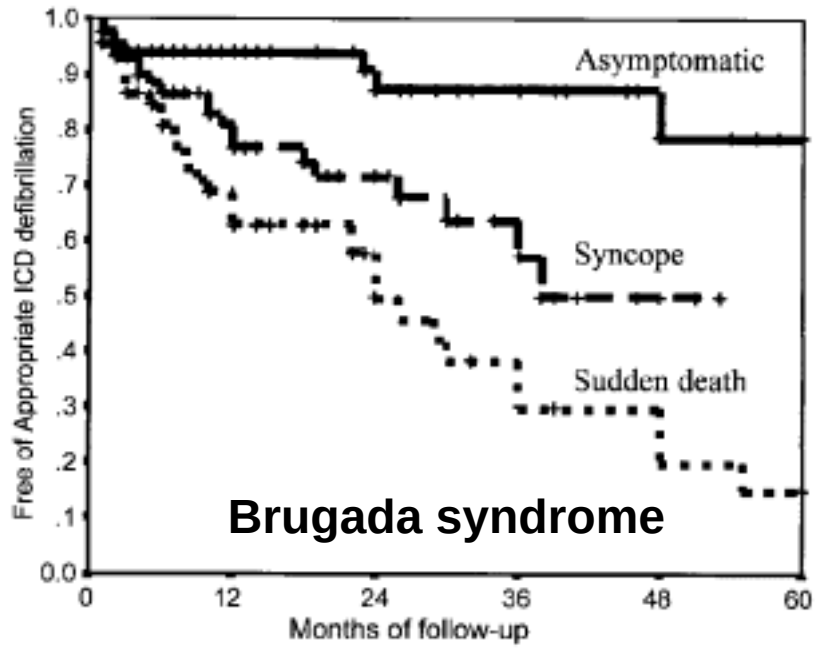
Syncope unexplained in 34 (30%) group I and 16 (27%) group II

J Am Coll Cardiol 2004;44:594–601

Sudden Death in Patients without Structural Heart Disease



J Am Coll Cardiol 2004;43:1137– 44



Circulation. 2005;111:659-670.

In contrast with earlier beliefs,
survivors of idiopathic VF are now considered at high risk
; Unexplained Cardiac Arrest Registry of Europe (RR 30%)

Role of EPS in patients with Unexplained Syncope

Class I

1. Pts with suspected structural heart disease and syncope that remains unexplained after appropriate evaluation
2. Pts with recurrent unexplained syncope without structural heart disease (; primary electrical disorder) and negative head-up tilt test.

Role of EPS in Survivors of Cardiac Arrest

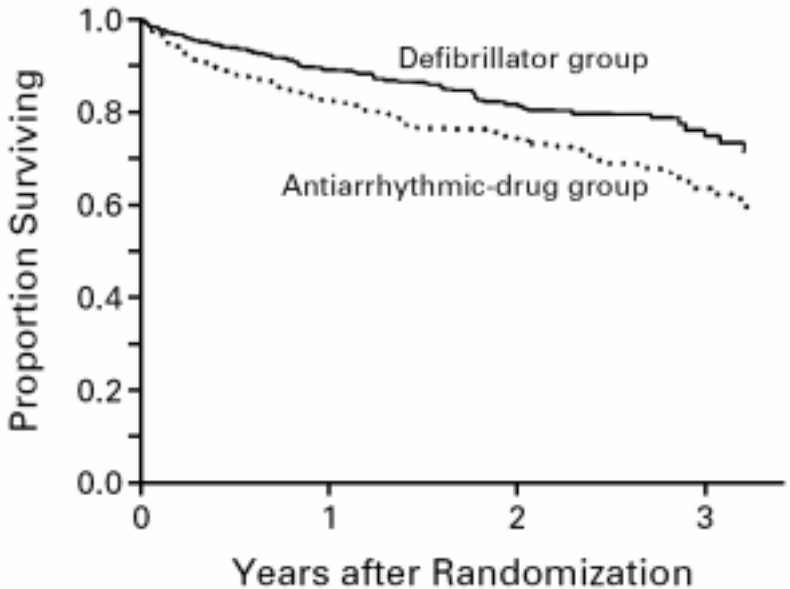
Class I

1. **Pts surviving cardiac arrest** without evidence of an acute Q-wave MI
2. Pts surviving cardiac arrest occurring **more than 48 hrs after the acute phase of MI in the absence of a recurrent ischemic event**

Class II

1. Cardiac arrest caused by bradyarrhythmia
2. ? Congenital repolarization abnormality

A COMPARISON OF ANTIARRHYTHMIC-DRUG THERAPY WITH IMPLANTABLE DEFIBRILLATORS IN PATIENTS RESUSCITATED FROM NEAR-FATAL VENTRICULAR ARRHYTHMIAS (AVID) INVESTIGATORS*



Patients at risk	1016	644	333	104
Percent surviving				
Defibrillator group		89.3	81.6	75.4
Antiarrhythmic-drug group		82.3	74.7	64.1

30% ↓ in RR of SCD

Overall Survival Rate
Antiarrhythmic group 64.1 % vs 75.4% of ICD group (P<0.02)

N Engl J Med 1997;337:1576-83

High Recurrence Rate of Arrhythmia
AVID - ICD Group

ICD provides a unique opportunity to study the Natural History of Arrhythmic Recurrence in patients with ventricular arrhythmia

After 3 years, the recurrence of arrhythmia in 64% of 491 patients assigned to an ICD

The cumulative % of Pts with any activation of ICD

	3 Month	I year	2 year	3 year
VT	36%	68%	81%	85%
VF	15%*	39%*	53%*	69%*

N Engl J Med 1997;337:1576-83

Implantable cardioverter-defibrillator therapy in survivors of out-of-hospital sudden cardiac death without inducible arrhythmias.

Survivors of SCD(N=194) in whom ventricular arrhythmias cannot be induced with programmed electrical stimulation .

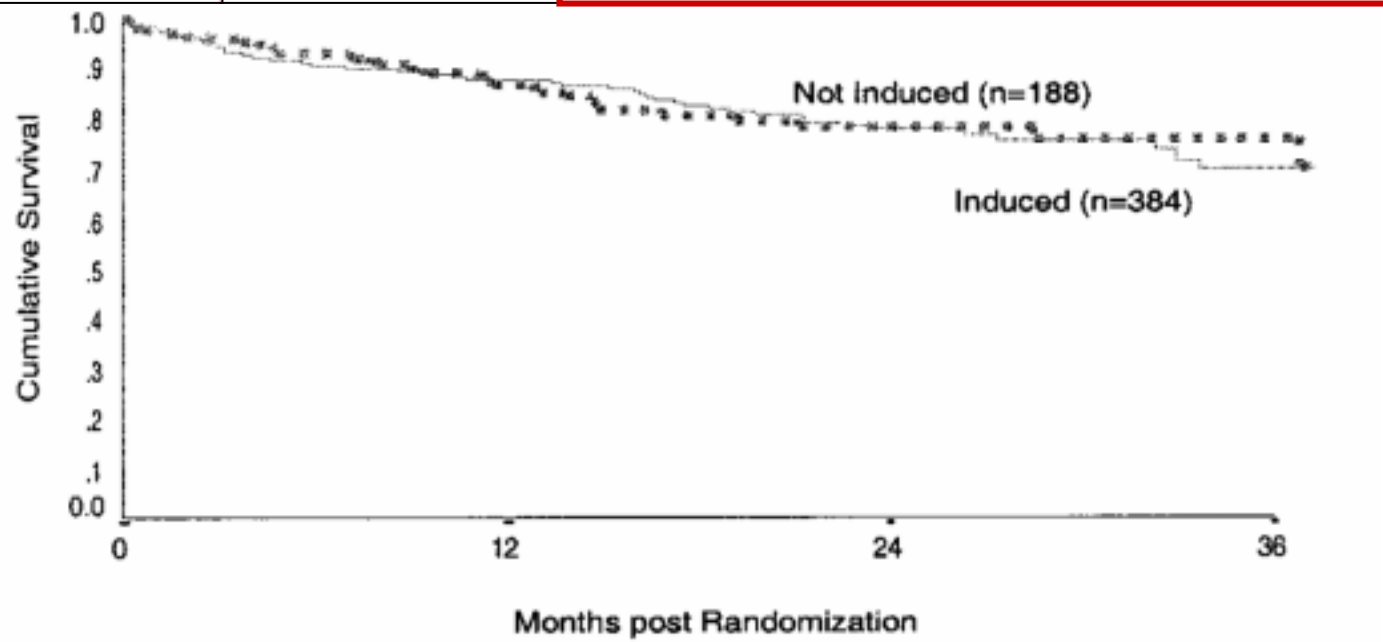
	ICD(N=99)	No ICD(N=95)
LVEF	43±16	48±18
Overall survival rate (at 2years)	0.88±0.04)	0.90±0.03
Sudden Death-Free survivial	0.97±0.02	0.90±0.03
Arrhythmic Events	28 (shock , 3 SD)	20 (18 fatal)

Survivors of SCD in whom no arrhythmias could be induced with EPS remained at risk for arrhythmia recurrence

Crandall BG, J Am Coll Cardiol. 1993 :21:1186-92

Prognostic value of Baseline Electrophysiology studies in patients with sustained ventricular tachyarrhythmia: The Antiarrhythmics Versus Implantable Defibrillators (AVID) trial

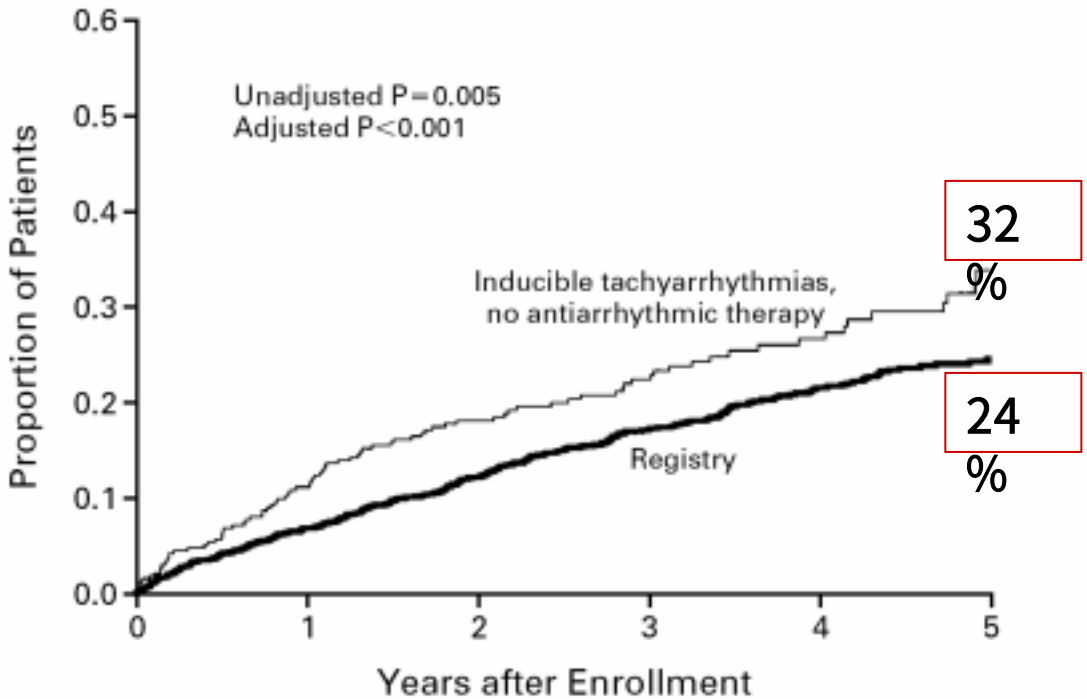
	No EP	EP	VT or VF inducible	VT or VF noninducible
Number of patients	444	572	384	188
Age (y) at index event	66 ± 10	65 ± 11	66 ± 10	62 ± 12*
EF (mean ± SD)	31 ± 14	32 ± 13	30 ± 11	36 ± 16*
Male sex	78	81	86	69*
White race	89	85	89	76*
Index event		*		*
VF	52	40	26	67
VT syncope	19	23	26	18
VT other	30	37	48	15



MUSTT

Cardiac Arrest or Death due to Arrhythmia

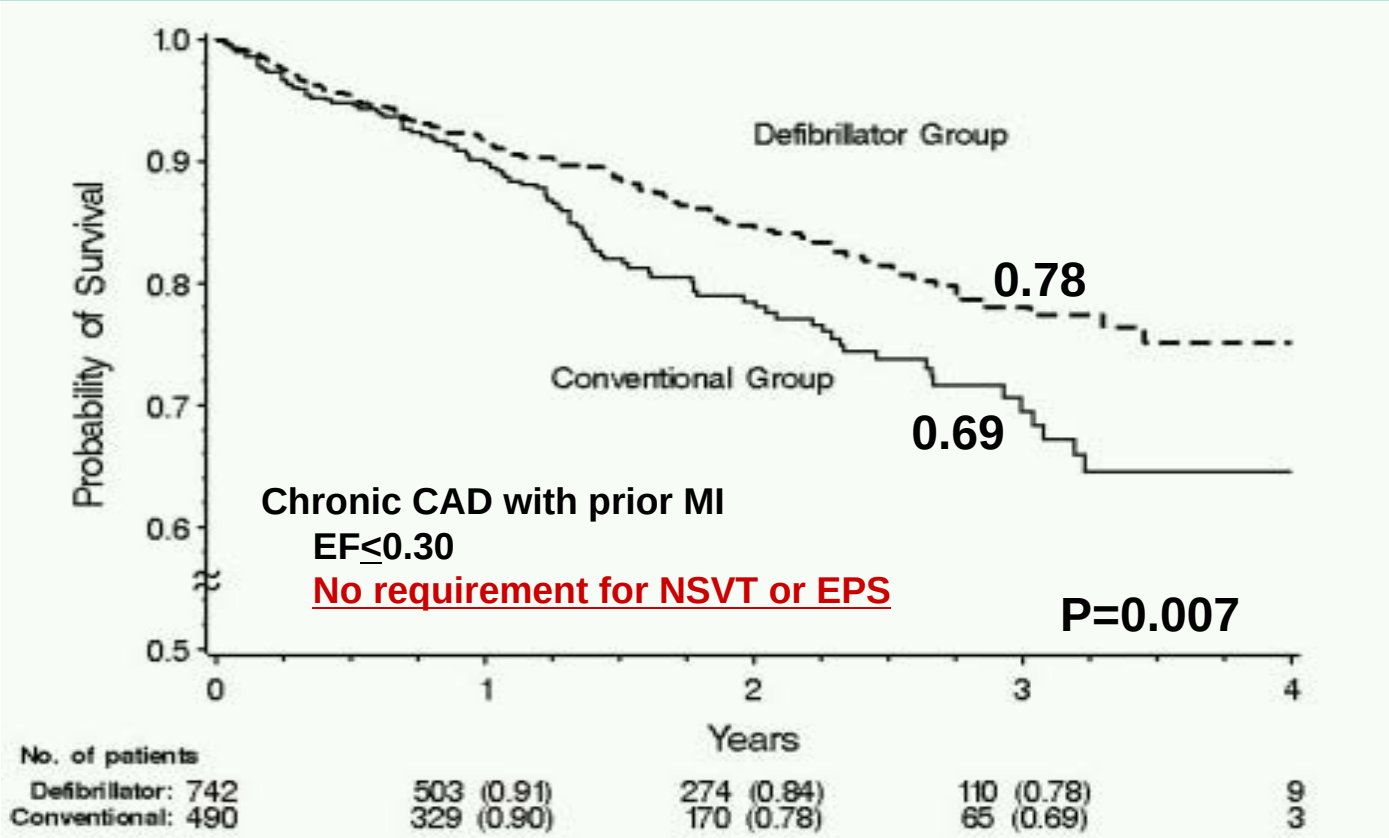
-1,435 patients without inducible tachyarrhythmia in registry



No. at Risk						
Inducible tachyarrhythmias, no antiarrhythmic therapy	353	290	242	178	118	67
Registry	1397	1212	1074	787	530	308

N Engl J Med 1999;341:1882-90

MADIT - II



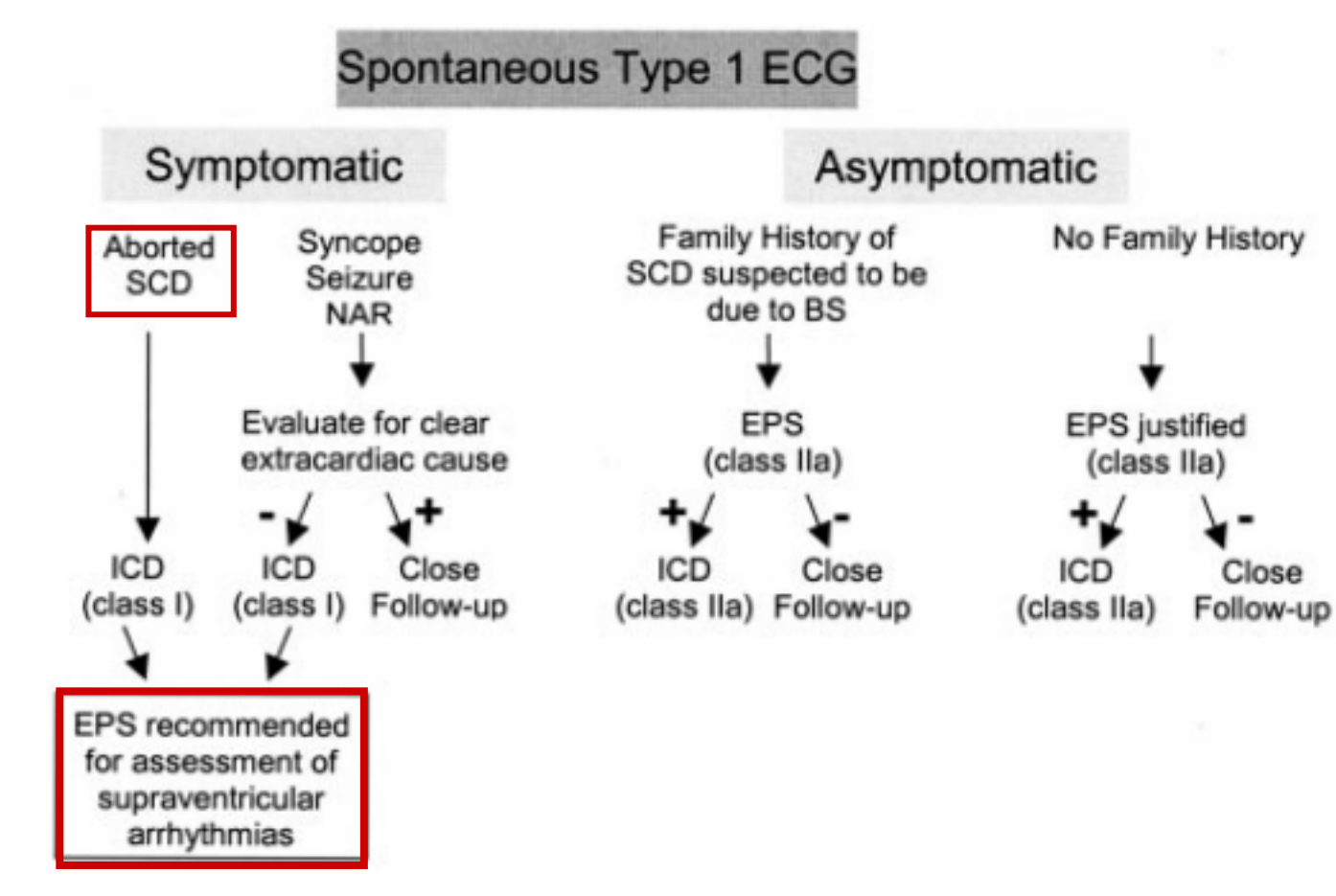
Low EF by itself is sufficient

to identify pts who will benefit from an ICD

EPS in Brugada Syndrome
reproducibility of VT or VF by EPS

	Brugada et al[9]	Brugada et al[2]	Priori et al[3]	Eckardt et al
Electrophysiological study, n (%)	252	408	86	186
Inducible	130 (52)	163 (40)	57 (66)	93 (50)
Aborted SCD	44/54 (83)	NA	18 (82)	15/22 (68)
Syncope	41/62 (68)	NA	NA	40/65 (62)
Asymptomatic	45/136 (33)	NA	NA	38/98 (39)

Brugada Syndrome Consensus Conference



Interpretation of EPS
: Negative EP Study

1. **The relatively high number of false negative results**
   - **Various Inducibility according to the underlying etiology & the arrhythmias presentation.**

   : The probability of induction of sustained-VT or VF in Pts with an episode of monomorphic VT (90–95%).
   : The probability of induction is lower in similar patients who present with cardiac arrest (<50%)

2. **EPS results more meaningful than clinical presentaion of SCD itself ?**

3. **Unexplained Cardiac Arrest in the absence of Heart Disease such as Primary Electrical Disorder**
   : ? enough data not yet

Role of Electrophysiological Study in Guiding Drug Therapy

Class I

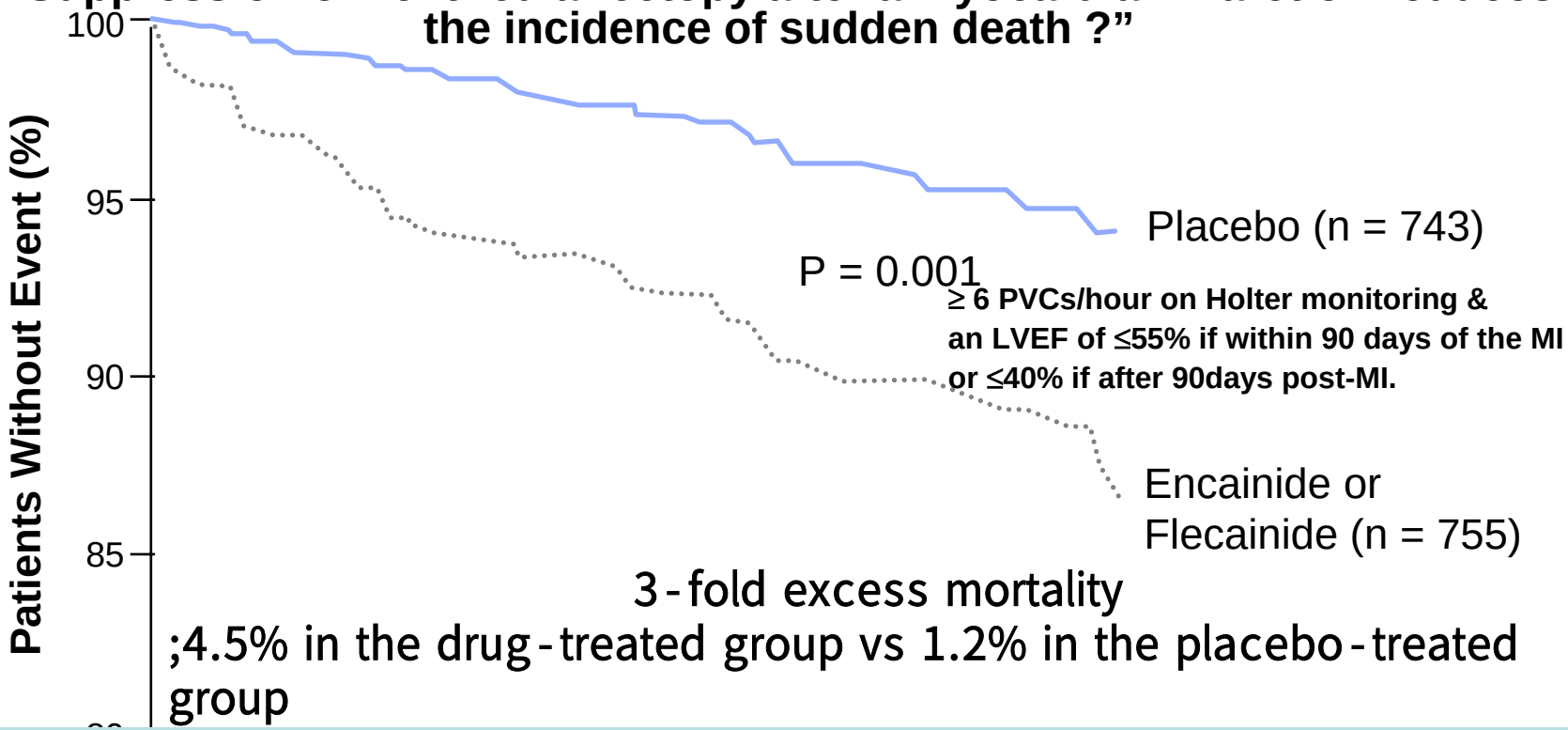
1. **Patients with sustained VT or cardiac arrest, especially those with prior MI**
2. Patients with AVNRT, AVRT using an accessory pathway, or A Fib. associated with an accessory pathway, for whom chronic drug therapy is planned

Class II

1. Patients with SNRT, AT, Afib. or AF without ventricular preexcitation syndrome, for whom chronic drug therapy is planned
2. Patients with arrhythmias not inducible during control EPS for whom drug therapy is planned

CAST I, II

"Suppression of ventricular ectopy after a myocardial infarction reduces the incidence of sudden death ?"



"clean" Holter monitor did not assure freedom from SCD

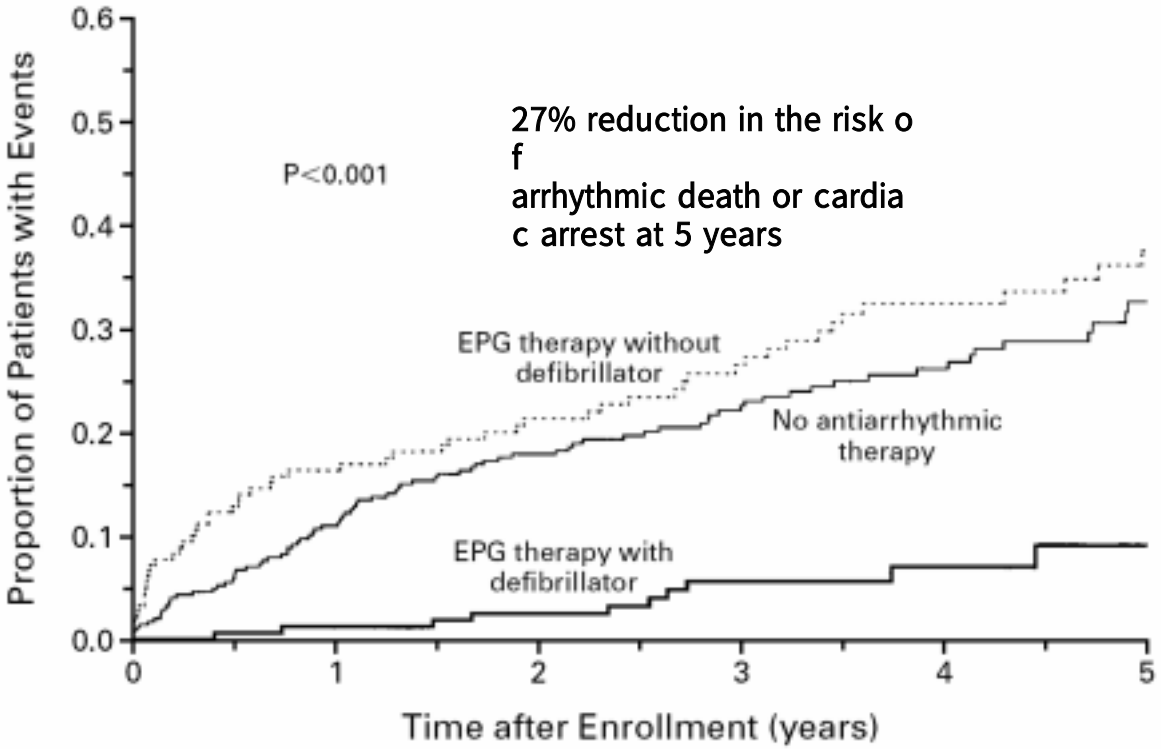
Echt DS. *N. Engl J Med* 1991;324:781-788.

The Multicenter Electrophysiologic Study versus Electrocardiographic Monitoring (ESVEM)study

- **486 patients with documented sustained VT/VF, cardiac arrest, or syncope, who had both inducible ventricular arrhythmias and spontaneous PVCS (≥10/hour)**
- **Serial testing of drug efficacy –**
  - EPS(n = 242) or Holter(n = 244)
- **EPS limb**
  drug efficacy prediction in 108 patients (45%),
  compared to 188 (77%) in the HM limb (P < 0.001)
- **Sotalol - lower probability of arrhythmia recurrence**
- **During long-term follow-up of the 296 patients discharged on a drug predicted to be effective, there were 151 recurrences of an arrhythmic event**
- **There were no differences in actuarial rates of arrhythmia recurrence between EPS and HM.**

Eur Heart J. 1993 Nov;14 Suppl H:78-84

EPS guided Antiarrhythmic Therapy MUSTT



1. No benefit with PVS-guided Drug Therapy

2. The lower rates of arrhythmic events among the patients assigned to EP guided therapy largely due to to the use of defibrillators

Empirical Antiarrhythmic Therapy
- Amiodarone -

Conventional versus Amiodarone Drug Evaluation Trial(CASCADE)

- Superiority of class III agents compared with class I agents

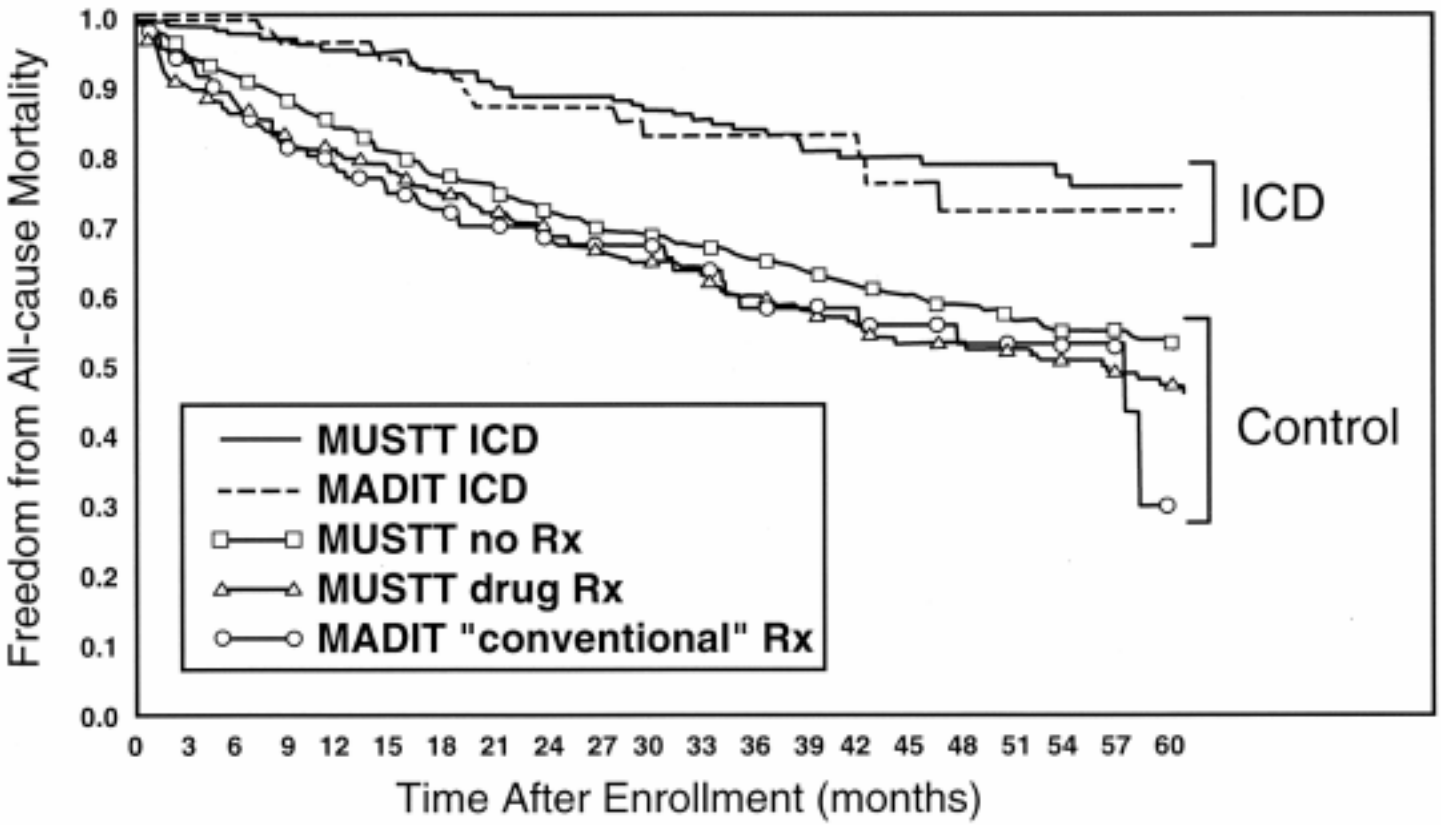


FIGURE 1. Kaplan-Meier survival curves for MUSTT and MADIT. These curves depict the freedom from all-cause mortality for the control and treated patient groups in the 2 studies. The 3 lower curves represent conventional (mostly amiodarone) therapy in MADIT, and electrophysiologic-guided antiarrhythmic drug therapy or no specific antiarrhythmic therapy in MUSTT. The 2 upper curves show survival outcomes for patients treated with ICDs in the 2 studies. The risk ratio for reduction in mortality for the ICD-treated patients versus the controls was 0.49 ($p < 0.0001$) for MUSTT and 0.46 ($p < 0.009$) for MADIT.

Am J Cardiol. 2000 Dec 1;86(11):1214-5,

Amiodarone or an ICD for CHF
SCD-HeF

- **Amiodarone or the ICD will decrease overall mortality in patients with CAD or Nonischemic cardiomyopathy who are in heart failure (NYHA) class II or III and have a LVEF < 35% ?**

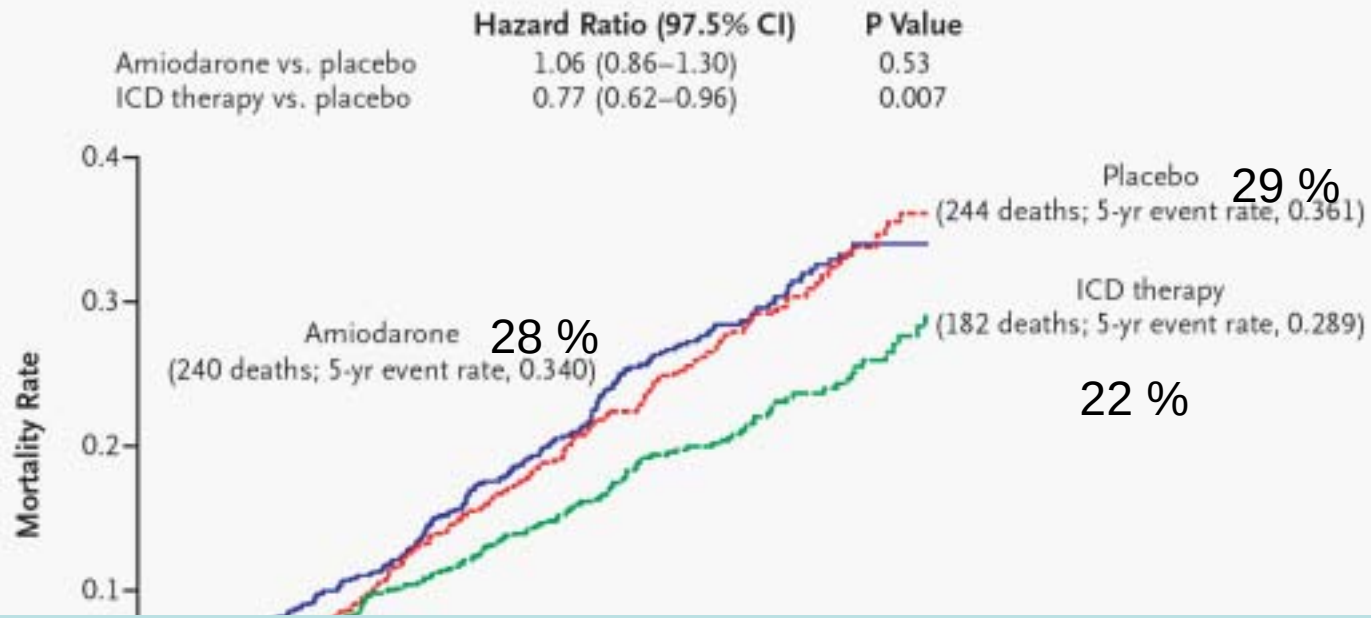
- **Randomly assigned 2521 Pts**
  1.conventional therapy for CHF plus placebo (n=847)
  2.conventional therapy plus amiodarone (n=845)
  3.conventional therapy plus single-lead ICD (n=829)
  Placebo and amiodarone were administered in a double-blind fashion.

- **The primary end point - death from any cause**.

- **The median LVEF - 25 percent**
- The cause of CHF - ischemic in 52 % and nonischemic in 48 %
- The median follow-up : 45.5 months.

N Engl J Med. 2005 Jan 20;352(3):225-37.

SCD-HeF



CONCLUSIONS:

1. **Amiodarone has no favorable effect on survival**
2. **Single-lead, shock-only ICD reduces overall mortality by 23 %**

Placebo	847	797	724	505	304	89
ICD therapy	829	778	733	501	304	103

N Engl J Med. 2005 Jan 20;352(3):225-37.

Limitation of Antiarrhythmic Therapy -ischemic VT of VF-

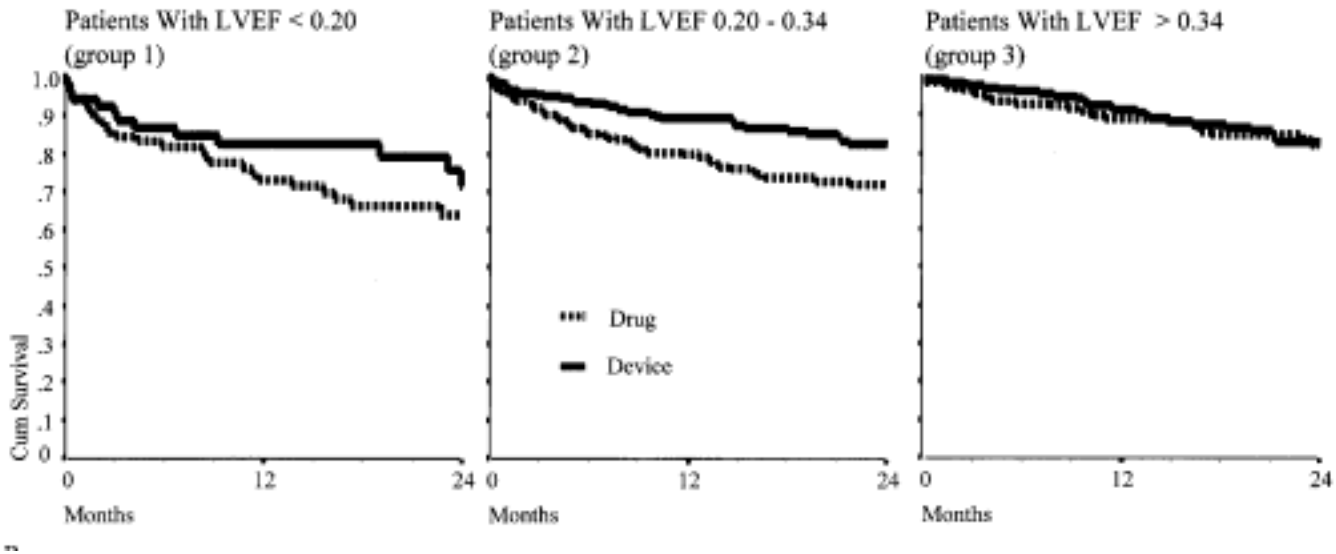
- **Limited to reproducibly inducible Sustained-VT**
  the underlying etiology
  the arrhythmias presentation.
- **The frequency of side effects of AADs**
- **The change of underlying disease state may alter the response**
- **The high variable recurrence rates on different drugs**
- **EPS-guided therapy is superior to Holter-guided therapy ?**
- **Alternative superior Px such as ICD**
- **More meaningful risk factor(like low EF < 30%) than ventricular arrhythmia**

Relative Effectiveness of the ICD and AADs in Patients With Varying Degrees of Left Ventricular Dysfunction Who Have Survived Malignant Ventricular Arrhythmias

	N. pts.	Mean age (yrs)	Women (%)	NYHA class > II (%)	Mean LVEF (%)	Follow-up (months)	Annual control group mortality (%)	Relative risk reduction in total mortality with ICD (%)
Secondary prevention trials								
AVID [4]	1016	65	21	9	32	18 ± 12	12	31
CIDS [5]	659	64	15	11	34	36	10	20
CASH [6]	288	58	20	17	45	57 ± 34	9	23
Meta-analysis [7]	1866	63	18	11	34	28	–	28
Primary prevention trials								
MADIT [8]	196	63	8	–	26	27	17	54
MUSTT [9]	704	67	10	24	30	39	14	51
MADIT-II [10]	1232	65	15	29	23	20	10	31
COMPANION [11]	1634	66	23	86	22	16	19	43

ICD, implantable cardioverter-defibrillator; LVEF, left ventricular ejection fraction; pts., patients.

Relative Effectiveness of the ICD and AADs in Patients With Varying Degrees of Left Ventricular Dysfunction Who Have Survived Malignant Ventricular Arrhythmias



Relatively well-preserved LVEF (≥0.35) may not have better survival when treated with the ICD as compared with AADs.

Role of EPS in Guiding Drug therapy

Class I

1. Pts with sustained VT or cardiac arrest, especially those with prior MI (; LVEF >35%)
2. Pts with AVNRT, AVRT, or A. Fib associated accessory pathway, for chronic drug therapy is planned

The Indications of EPS

- **Diagnostic aspect**

  The uncertainty of a causal relation between an arrhythmia and the symptoms

  Differential diagnosis

- **Therapeutic aspect**

  The widespread use of catheter ablation

- **Prognosis and Risk stratification**

  The growing usage of ICDs

  Primary electrical disorder