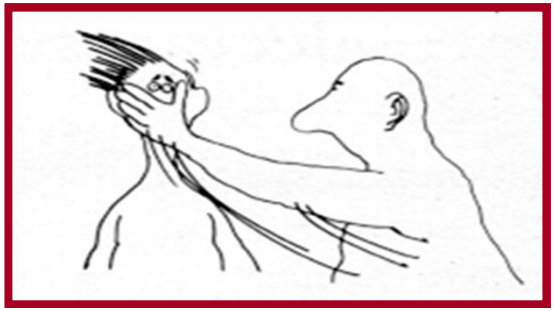
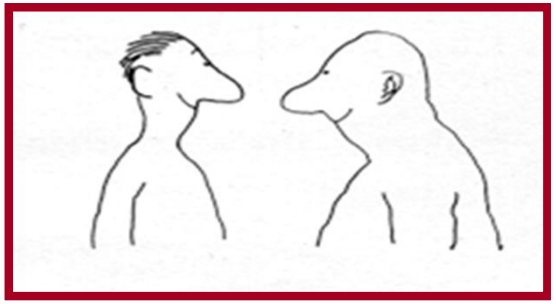
Shock Reduction Strategies

Michael Geist
E. Wolfson MC

Shock Therapy





Thanks, I needed that!

Why Do We Need To Reduce Shocks

Shocks burden and increased mortality in implantable cardioverter-defibrillator patients

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BACKGROUND Implantable cardioverter-defibrillator (ICD) shocks are associated with an increased risk of death. It is unclear whether ICD shocks are detrimental *per se* or a marker of higher risk patients.

OBJECTIVE We aimed to assess the association between ICD shocks and time to death after correction for baseline mortality based on the Seattle Heart Failure Model (SHFM).

METHODS The primary analysis compared time-to-death between patients receiving no shocks and patients receiving shocks of any type adjusted for SHFM score at time of implantation and other comorbidities. Subgroup analyses were performed to further describe the relationship between shocks and mortality risk.

RESULTS Over a median follow-up of 41 months (interquartile range 23–64), one or more shock episodes occurred in 59% of 425 patients and 40% of the patients died. Patients receiving shocks of any type had increased risk of death (hazard ratio 1.55; 95% confidence interval 1.07–2.23; $P = .02$) versus patients receiving no shocks. While patients with 1–5 days with shock (shock days) did not show evidence of increased risk of death (1.30 [0.88–1.94]; $P = 0.19$), those with 6–10 shock days (2.22 [1.21–4.08]; $P < .01$) and >10 shock days (3.66 [1.86–7.19]; $P < .01$) had increasingly higher risk. There was no increased hazard for death (0.73 [0.34–1.57]; $P = .41$) in patients treated only with antitachycardia pacing (ATP).

CONCLUSION ICD shocks were associated with increased mortality risk after adjustment for SHFM-predicted mortality, and the burden of shocks played a role in this association. ATP did not increase mortality risk, suggesting that shocks may themselves be detrimental.

KEYWORDS Implantable cardioverter-defibrillator; Shocks; Antitachycardia pacing; Ventricular arrhythmia; Death

ABBREVIATIONS **ATP** = antitachycardia pacing; **AF** = atrial fibrillation; **CAD** = coronary artery disease; **CHF** = congestive heart failure; **CI** = confidence interval; **CKD** = chronic kidney disease; **DM** = diabetes mellitus; **EF** = ejection fraction; **HR** = hazard ratio; **HTN** = hypertension; **ICD** = implantable cardioverter defibrillator; **IQR** = interquartile range; **SHFM** = Seattle Heart Failure Model; **VA** = ventricular arrhythmia; **VF** = ventricular fibrillation; **VT** = ventricular tachycardia

(Heart Rhythm 2011;8:1881–1886) Published by Elsevier Inc. on behalf of the Heart Rhythm Society.

Long-term outcome after ICD and CRT implantation and influence of remote device follow-up: the ALTITUDE survival study.

Saxon LA, Hayes DL, Gilliam FR, Heidenreich PA, Day J, Seth M, Meyer TE, Jones PW, Boehmer JP.
Circulation. 2010 Dec 7;122(23):2359-67

- Survival status in patients implanted with ICD and CRT devices across the United States from a single manufacturer was assessed. Outcomes were compared between patients followed in device clinic settings and those who regularly transmit remote data collected from the device an average of 4 times monthly. Shock delivery and electrogram analysis could be ascertained from patients followed on the network, enabling survival after ICD shock to be evaluated. **One- and 5-year survival rates in 185,778** patients after ICD implantation were 92% and 68% and were 88% and 54% for CRT-D device recipients. In 8228 patients implanted with CRT-only devices, survival was 82% and 48% at 1 and 5 years, respectively. For the 69,556 ICD and CRT-D patients receiving remote follow-up on the network, 1- and 5-year survival rates were higher compared with those in the 116,222 patients who received device follow-up in device clinics only (50% reduction; P<0.0001). There were no differences between patients followed on or off the remote network for the characteristics of age, gender, implanted device year or type, and economic or educational status. **Shock therapy was associated with subsequent mortality risk for both ICD and CRT-D recipients.**
- **CONCLUSIONS:**
- Survival after ICD and CRT-D implantation in patients treated in naturalistic practice compares favorably with survival rates observed in clinical trials.
- Remote follow-up of device data is associated with excellent survival, but arrhythmias that result in device therapy in this population are associated with a higher mortality risk compared with patients who do not require shock therapy.

Shock Reduction Strategies
Arrhythmia Reduction Methods

- **Treat precipitating factors:**
  - Electrolyte abnormality.
  - CHF -including CRT implant.
  - Avoid proarrhythmic medications.
  - Consider arrhythmic inducing pacing sites.
  - Use Guidelines recommended anti arrhythmics – ACE inhibitors, Statins, Beta-blockers.
  - Correct Ischemia.
  - Correct bradycardia
  - Treat Endocrine abnormalities (thyrotoxicosis..).

Geist M, Rozenman Y. **Patients with recurrent malignant ventricular arrhythmias--therapeutic challenge.** Harefuah. 2006 May;145(5):348-9, 398

Shock Reduction Strategies
Arrhythmia Reduction Methods

Specific treatment.

- Anti arrhythmic therapy.
- Avoid inappropriate treatment
- Avoid hasty appropriate treatment -
- ATP
- VT Ablation & Scar excision.

Geist M, Rozenman Y. **Patients with recurrent malignant ventricular arrhythmias--therapeutic challenge.** Harefuah. 2006 May;145(5):348-9, 398

Prevention of ICD shocks by treatment with sotalol. Antonio Pacificio , Stephan Hohnloser….Eric N Prystovsky NEJM 1999;340:1885-1962

302 Patients RCT 160-320 mg Sotalol /day ,f/u 12 month.

- 41 European,3 USA centers.
- Mean age 61Placebo 63 Sotalol
- LVEF% 39 Placebo 37 Sotalol
- Mean/median dose 207±55/242 mg Sotalol
- Discontinue: Sotalol -34%
  - Placebo 35%
- OUTCOME:

Death	7 Placebo	4 Sotalol
DC	73(48%)	45(30%)

Comparison of β-Blockers, Amiodarone Plus β-Blockers, or Sotalol for Prevention of Shocks From Implantable Cardioverter Defibrillators

The OPTIC Study: A Randomized Trial

OPTIC STUDY

Design, Setting, and Patients A randomized controlled trial with blinded adjudication of events of 412 patients from 39 outpatient ICD clinical centers located in Canada, Germany, United States, England, Sweden, and Austria, conducted from January 13, 2001, to September 28, 2004. Patients were eligible if they had received an ICD within 21 days for inducible or spontaneously occurring ventricular tachycardia or fibrillation.

Intervention Patients were randomized to treatment for 1 year with amiodarone plus β-blocker, sotalol alone, or β-blocker alone.

Main Outcome Measure Primary outcome was ICD shock for any reason.

Results Shocks occurred in 41 patients (38.5%) assigned to β-blocker alone, 26 (24.3%) assigned to sotalol, and 12 (10.3%) assigned to amiodarone plus β-blocker. A reduction in the risk of shock was observed with use of either amiodarone plus β-blocker or sotalol vs β-blocker alone (hazard ratio [HR], 0.44; 95% confidence interval [CI], 0.28-0.68; $P<.001$). Amiodarone plus β-blocker significantly reduced the risk of shock compared with β-blocker alone (HR, 0.27; 95% CI, 0.14-0.52; $P<.001$) and sotalol (HR, 0.43; 95% CI, 0.22-0.85; $P=.02$). There was a trend for sotalol to reduce shocks compared with β-blocker alone (HR, 0.61; 95% CI, 0.37-1.01; $P=.055$). The rates of study drug discontinuation at 1 year were 18.2% for amiodarone, 23.5% for sotalol, and 5.3% for β-blocker alone. Adverse pulmonary and thyroid events and symptomatic bradycardia were more common among patients randomized to amiodarone.

Conclusions Despite use of advanced ICD technology and treatment with a β-blocker, shocks occur commonly in the first year after ICD implant. Amiodarone plus β-blocker is effective for preventing these shocks and is more effective than sotalol but has an increased risk of drug-related adverse effects.

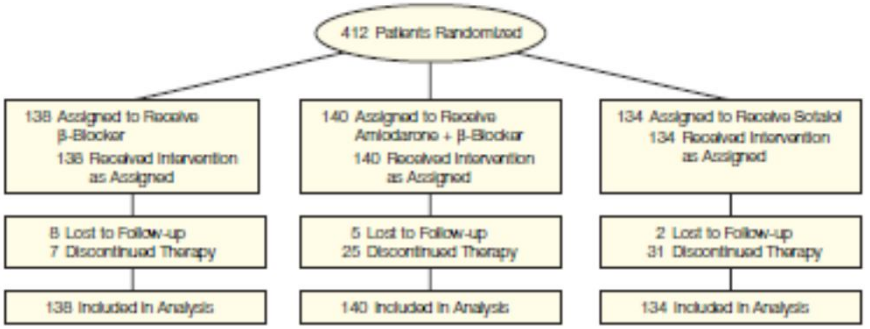
OPTIC STUDY

Table 4. Adverse Events of the 3 Treatment Assignments

Adverse Event	No. of Patients (%)			*P* Value*
	β-Blocker (n = 138)	Amiodarone + β-Blocker (n = 140)	Sotalol (n = 134)	
Death	2 (1.4)	6 (4.3)	4 (3.0)	.36
Arrhythmic death	1 (0.7)	2 (1.4)	1 (0.8)	.60
Myocardial infarction	1 (0.7)	1 (0.7)	0	.62
Heart failure	9 (6.5)	12 (8.6)	14 (13.4)	.14
Atrial fibrillation	6 (4.4)	1 (0.7)	6 (4.5)	.13
Pulmonary adverse event	0	7 (5.0)	4 (3.0)	.03
Hypothyroidism	0	6 (4.3)	1 (0.8)	.01
Hyperthyroidism	0	2 (1.4)	0	.14
Symptomatic bradycardia	1 (0.7)	8 (6.4)	2 (1.5)	.009
Torsades de pointes	0	0	0	>.99
Skin adverse event	2 (1.5)	4 (2.9)	3 (2.2)	.72
Device infection	1 (0.7)	2 (1.4)	4 (3.0)	.34
Hospitalized during follow-up	60 (43.3)	49 (34.9)	40 (30.1)	.32

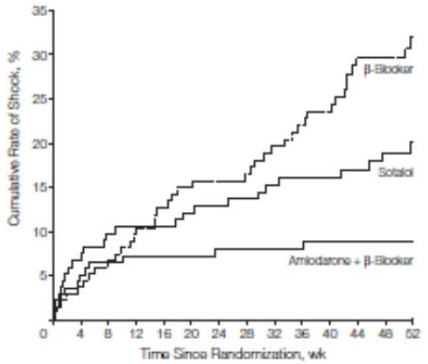
OPTIC

Figure 1. Flow of Patients in the OPTIC Trial



OPTIC indicates Optimal Pharmacological Therapy in Cardioverter Defibrillator Patients.

Figure 2. Cumulative Rate of Shock for the 3 Treatment Groups by Time Since Randomization



No. at Risk					
β-Blocker	138	119	109	91	42
Sotalol	134	118	108	94	35
Amiodarone + β-Blocker	140	124	115	106	56

Log-rank $P<.001$ for amiodarone plus β-blocker vs β-blocker alone, log-rank $P=.02$ for amiodarone plus β-blocke vs sotalol alone, and log-rank $P=.055$ for sotalol vs β-blocker.

Methods To Avoid Or Reduce Inappropriate Shocks Therapies.

- High cut off – Detect only at faster rhythms.
- Sudden onset.
- Stability.
- Detect during charge.
- Reconfirmation post charge.
- Dual chamber sensing. (DATAS trial)
- QRS template Identification.
- Remote monitoring.

DATAS Europace. 2008 May;10(5):528-35.

Methods To Avoid or Reduce Appropriate Shocks Therapies.

- Programming ATP prior to DC in all zones.
- Avoidance of “Shock box”, Programming multiple zones-PainFREE Rx II.
- Prolonged detection – ADVANCE , “MADIT RIT”

Single Vs. Multiple Zones

Real world evaluation of dual-zone ICD and CRT-D programming compared to single-zone programming: the ALTITUDE REDUCES study.

- frequency of appropriate and inappropriate shocks and survival in
- patients were followed for 1.6 ± 1.1 years.
- The 12-month incidence of any shock was lower for dual-versus single-zone programmed detection at rates ≤170 bpm and between 170-200 bpm (P < 0.001).
- Appropriate shock rates at 1 year were also lower with dual-zone programming in these rate intervals (single zone 9.1%, 5.4%, P < 0.001, dual zone 6.7%, 4.7%, P < 0.02).
- There were no detectable differences between single- and dual-zone shock incidence at detection rates ≥ 200 bpm (P = 0.14).
- Inappropriate shock incidence was less with dual- versus single-zone detection at all detect rates <200 bpm, but not at rates ≥200 bpm (P < 0.001, P = 0.37).
- The lowest risk of appropriate and inappropriate shock was associated with dual-zone programming and detection rates ≥200 bpm (2.1%).
- Dual-zone detection was associated with more nonsustained and diverted therapy episodes but these patients did not have an increased risk of death compared to patients with single-zone programming.
- Patients programmed to low detection rate, single-zone detection and shock-only therapy also had the highest preshock mortality risk (P = 0.05).
- **CONCLUSIONS:**
- Shock incidence is lowest with either single- or dual-zone detection ≥200 bpm.
- For detection rates <200 bpm, dual-zone programming is associated with a reduction in the incidence of total shocks, appropriate shocks, and inappropriate shocks.

Gilliam FR, Hayes DL, Boehmer JP, Day J, Heidenreich PA, Seth M, Jones PW, Stein KM, Saxon LA.J Cardiovasc Electrophysiol. 2011 Sep;22(9):1023-9.

Meta analysis of Studies to Prevent DC.

Table 1 Characteristics of 17 studies included in the meta-analysis of the impact of interventions to reduce ICD shocks on mortality

Studies	Sample size (study group size) (n)	Duration of follow-up (years)	Study intervention	Control therapy	Age (mean ± SD) (years)	Male (%)	Ischemic heart disease or previous myocardial infarction (%)	Patients with previous ventricular arrhythmia (%)	Left ventricular ejection fraction (mean ± SD) (%)	New York Heart Association class III or IV (%)	β-Blocker use (%)
Antiarrhythmic Medication											
ALPHEE[26]	486 (377)	0.75	Amiodarone 200 mg/day, celivarone 50 mg/day, 100 mg/day, 300 mg/day	Placebo	64 ± 11	90	53	100	29 ± 8	25	90
Kettering et al[12]	100 (50)	2	Sotalol	Metoprolol	60 ± 10	83	73	100	38 ± 15	33	100
Kuhlkamp et al[11]	93 (46)	1	Sotalol	No antiarrhythmic treatment	62 ± 18	88	74	100	37 ± 19	14	NA
Pacifico et al[10]	302 (151)	1	Sotalol	Placebo	62 ± 11	83	70	100	38 ± 13	5	78
OPTIC[9]	412 (274)	1	Amiodarone + metoprolol or sotalol	Metoprolol	64 ± 10	81	81	72	34 ± 11	52	79
O'Toole et al[29]	160 (75)	0.6	Dofetilide	Placebo	NA	NA	NA	100	NA	NA	NA
Seidl et al[27]	70 (35)	2.2	Sotalol	Metoprolol	62 ± 10	89	80	100	40 ± 10	NA	100
SHIELD[13]	633 (419)	0.75	Azimilide 75 mg/day, 125 mg/day	Placebo	63 ± 12	90	64	100	35 ± 14	10	78
Singer et al[28]	172 (135)	0.75	Azimilide 35 mg/day, 75 mg/day, 125 mg/day	Placebo	66 ± 11	88	81	100	31 ± 12	6	43
Catheter Ablation											
Koa-Wing et al[31]	21 (12)	1.3	ICD + catheter ablation	ICD	NA	NA	100	100	35 ± 14	NA	NA
SMASH-VT[19]	128 (64)	1.9	ICD + catheter ablation	ICD	66 ± 10	87	100	100	32 ± 9	20	96
V-TACH[30]	107 (52)	1.9	ICD + catheter ablation	ICD	66 ±8	93	100	100	34 ± 9	NA	75
Enhanced ICD Programming to Reduce Appropriate Shocks											
ADVANCE CRT-D[32]	526 (266)	1	Biventricular ATP	Right ventricular ATP	67 ± 10	85	64	19	25 ± 6	NA	73
ADVANCE-D[33]	925 (450)	1	15 beat ATP	Eight-beat ATP	64 ± 12	88	75	59	34 ± 12	31	63
EMPIRIC[23]	900 (445)	1	Empiric ICD programming	Physician-tailored ICD programming	65 ± 13	81	70	53	32 ± 13	15	73
PAINFREE-II[21]	634 (313)	0.9	ATP	No ATP	67 ± 11	78	64	52	32 ± 13	19	59
PITAGORA[22]	206 (103)	3	ATP ramp	ATP burst	67 ± 11	81	63	48	32 ± 13	56	71

ATP = antitachycardia pacing; ICD = implantable cardioverter-defibrillator.

Implantable cardioverter-**defibrillator shock** prevention does not reduce mortality: A systemic review Ha AH, Ham I, Nair GM, Connolly SJ, Dorian P, Morillo CA, Healey JS. Heart Rhythm.2012 ;12:2068-2074.

ICD Trials With Algorithms To Prevent Shocks (pre MADIT RIT)

Enhanced ICD Programming to Reduce Appropriate Shocks

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Specific Trials

PREPARE Strategic Programming of Detection and Therapy Parameters in Implantable Cardioverter-Defibrillators Reduces Shocks in Primary Prevention Patients:

- Prospective, historic cohort controlled study Vs. -Primary prevention ICD indications
- 700 pts - October 2003 – May 2005
- 1 year follow-up
- Medtronic Marquis-based ICD's and leads, Single, dual and Bi-V patients.
- MIRACLE ICD -978 patients Bi-V devices 415 primary prevention patients.
  - EMPIRIC trial – 900 dual chamber ICD ,276 primary prevention patients Total Control Cohort
  - 691 primary prevention, Bi-V and Non Bi-V

Bruce L. Wilkoff et al.. **Results from the PREPARE (Primary Prevention Parameters Evaluation) Study1.** J Am Coll Cardiol 2008; 52:541-50

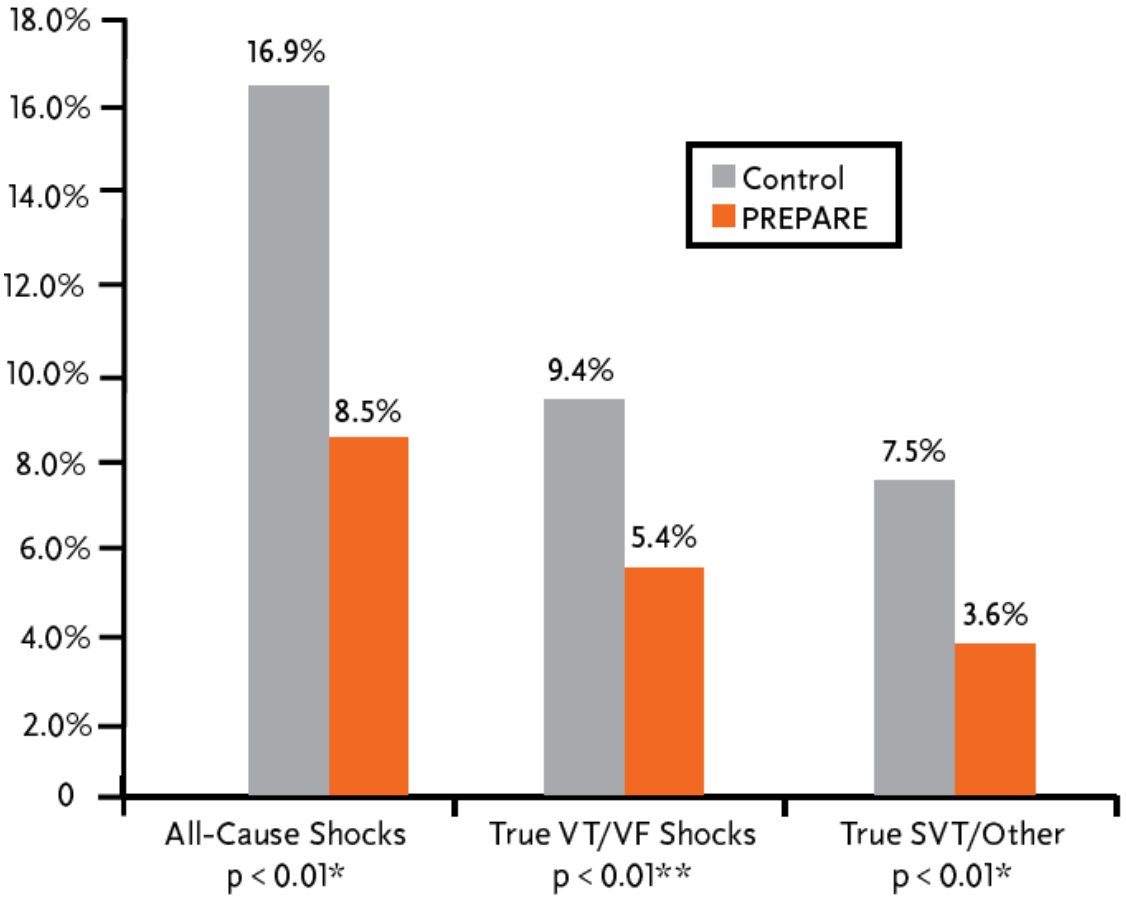
VT/VF Detection

Detection	Heart Rate	Beats to Detect	Therapies
VF ON	> 250 bpm	30 of 40	30-35 J
FVT Via VF	182-250 bpm	(30 of 40)	1 seq ATP, 30-35J
VT Monitor	167-181 bpm	32	None

PR Logic ON: AF/Afl, Sinus Tach (**1:1 VT-ST = 66%**) or

Wavelet ON: SVT Limit = 200 bpm

Patients Shocked at One year[1]



* Results remain significant after adjusting for differences in baseline characteristics.
** Not significant after adjusting for differences in baseline characteristics.

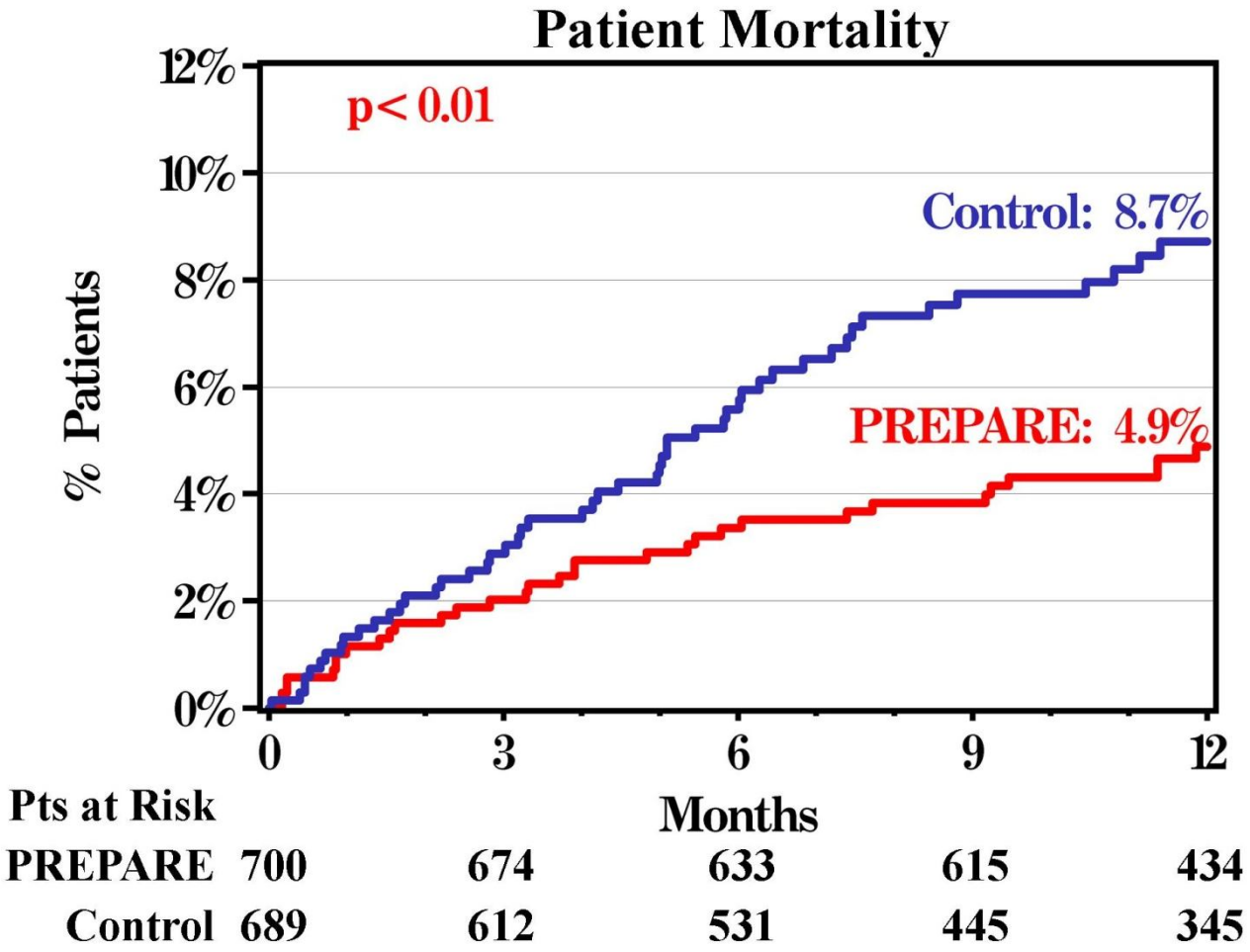
1 Wilkoff BL, Williamson BD, Stern RS, et al. Strategic programming of detection and therapy parameters in implantable cardioverter-defibrillators reduces shocks in primary prevention patients: results from the PREPARE (Primary Prevention Parameters Evaluation) study. *J Am Coll Cardiol*. August 12, 2008;52(7):541-550.

Syncope

Adverse Event	Pts (%) Events (n=700)
Syncope and near-syncope	131 (18.7%) 290
Arrhythmia-related	27 (3.9%) 31
True syncope	31 (4.4%) 40
Arrhythmia-related	11 (1.6%) 12
Related to PREPARE programming	9 (1.3%) 10

- 10 events identified as possibly or probably related to PREPARE programming in 9 patients.
  - None associated with injuries or death
  - 7 patients completed study
  - 2 patients withdrew for other reasons

Mortality


Patient Mortality
p< 0.01
Control: 8.7%
PREPARE: 4.9%
% Patients
12%
10%
8%
6%
4%
2%
0%
0
3
6
9
12
Months
Pts at Risk
PREPARE 700 674 633 615 434
Control 689 612 531 445 345

PainFREE R_x II
Prospective, Randomized Multicenter Trial of Empirical ATP versus Shocks for Fast VT in ICD Patients:

- 634 patients-Single-Blinded (248 PRIMARY 334 secondary 52 non standard)
- Enrollment: January 2001 -April 2003
- Demographics:
- Age -67, 32% LVEF, 80% Male, 85% CAD , 48 % 1 prevention.
- Required Detection Programming:
  - Fast VT via VF
  - # intervals to detect = 18/24
  - PR Logic “ON” in all dual chamber ICD, SVT limit of 320ms.
  - Zones: VF 240 (250 ms), FVT via VF 188 (320 ms), VT 167 (360 ms)

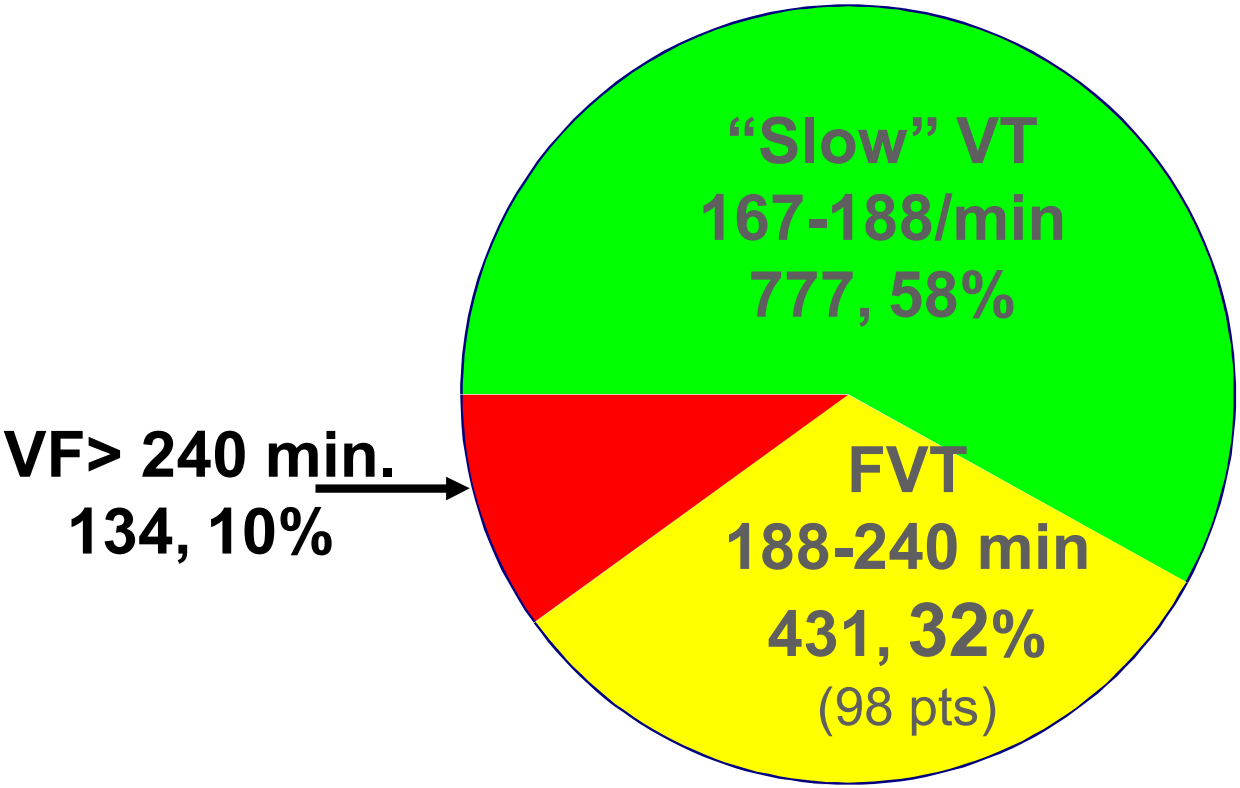
Wathen MS, et al. Prospective randomized multicenter trial of empirical antitachycardia pacing versus shocks for spontaneous rapid ventricular tachycardia in patients with implantable cardioverter defibrillators: PainFREE Rx II Trial Results. Circulation 2004;110:2591-2596.

PainFREE R_x II

Required FVT Therapy

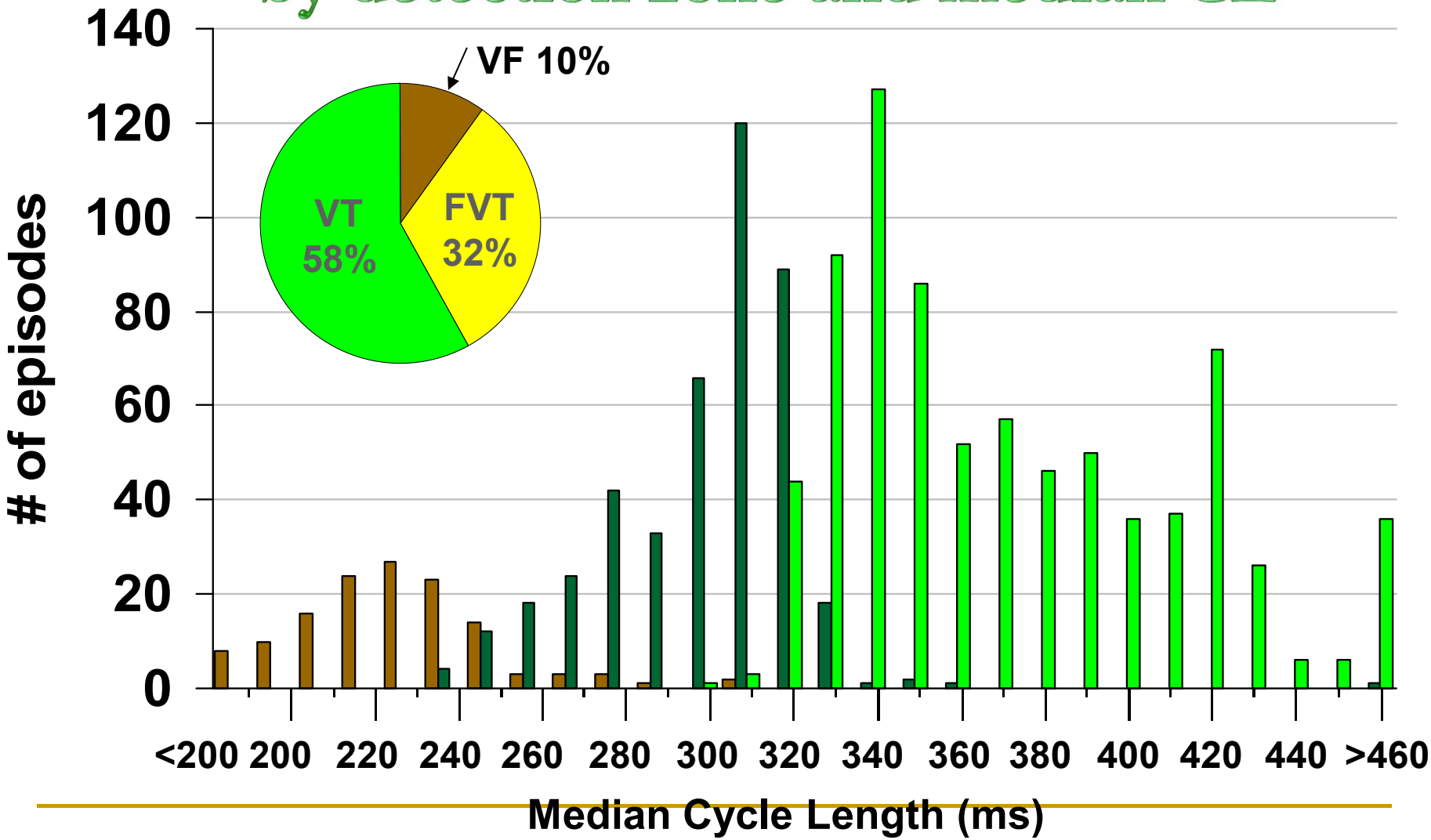
	ATP Arm	Shock Arm
R_x1	Burst ATP - 1 sequence - 8 pulses - 88% of VTCL	Shock DFT+10 J
R_x2	Shock DFT+10 J	Shock max output
R_x3-6	Shock max output	Shock max output

True Ventricular Episodes* (n=1342)

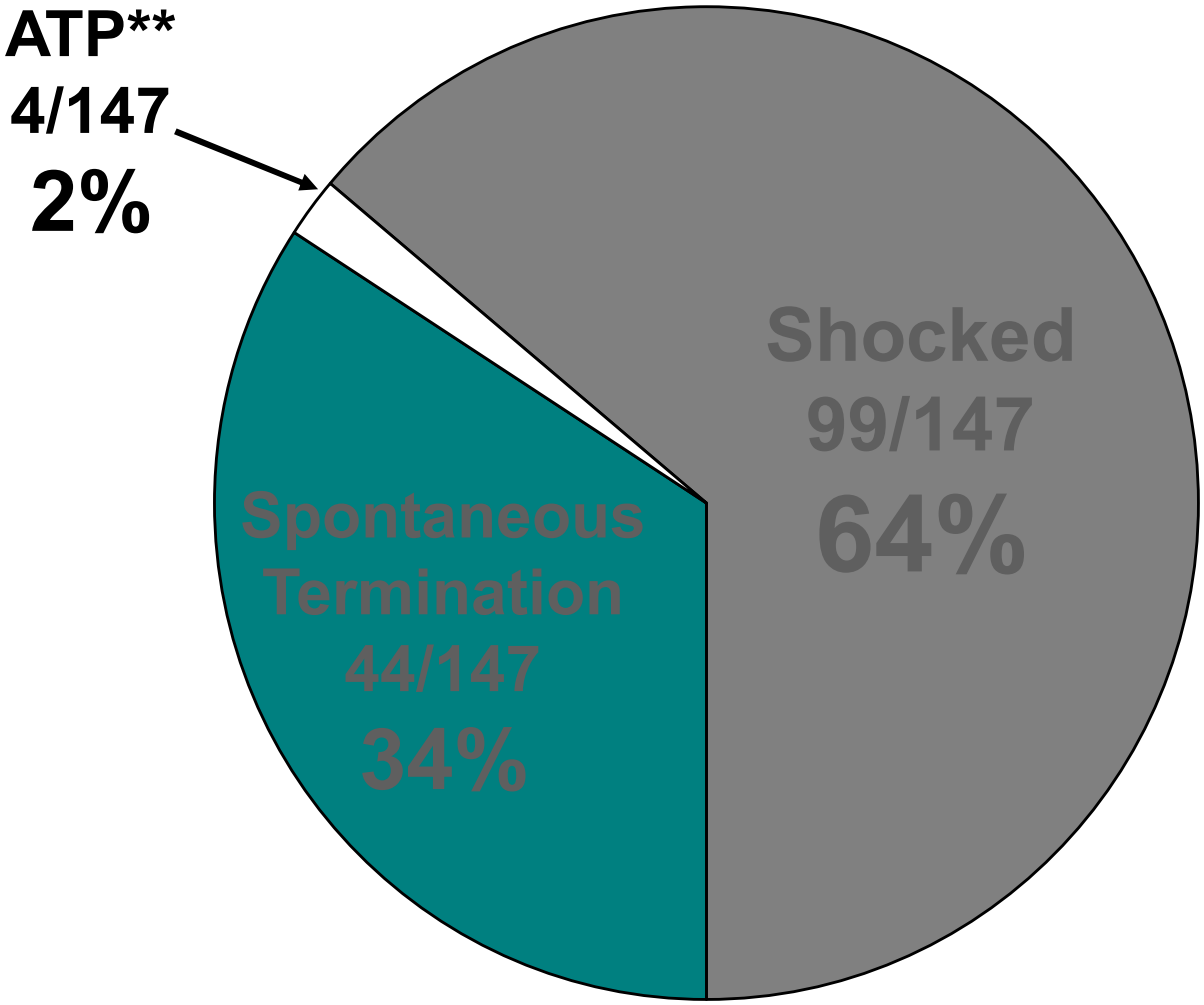


*Rhythms adjudicated by a physician panel

Distribution of ventricular arrhythmias by detection zone and median CL

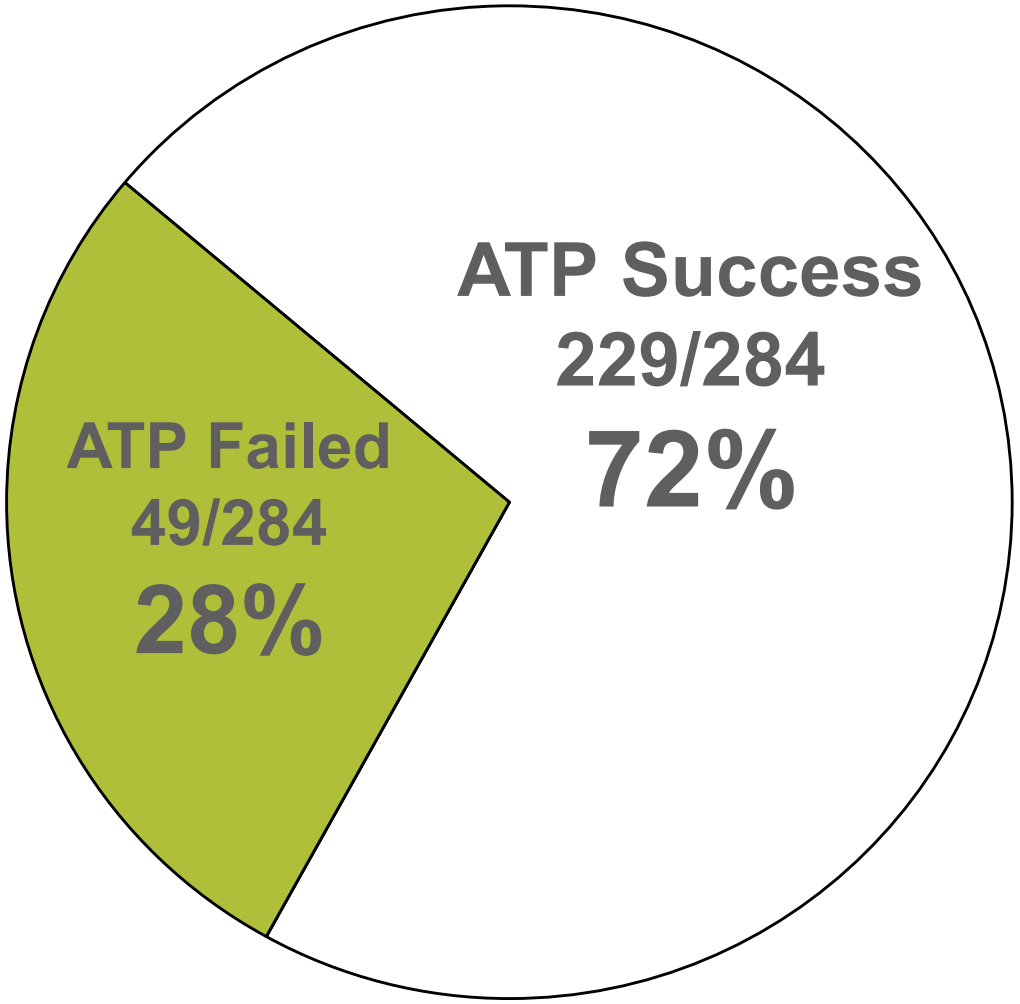


FVT Outcome: Shock Arm

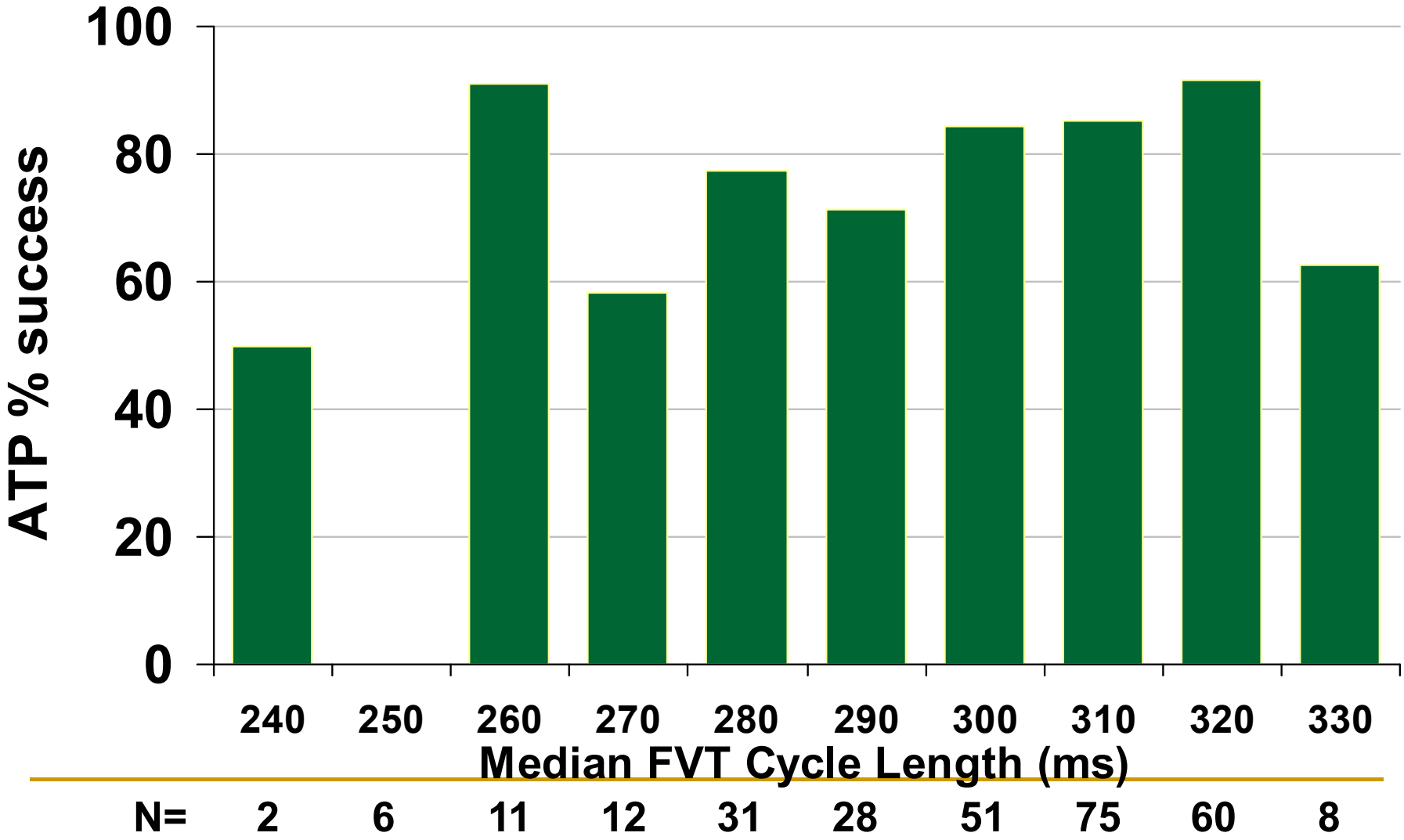


- Percentages adjusted for patients with multiple episodes (generalized estimating equation used)
- **crossover patients

FVT Outcome: ATP Arm



* Percentages adjusted for patients with multiple episodes (generalized estimating equation used)


ATP % success
100
80
60
40
20
0
240
250
260
270
280
290
300
310
320
330
Median FVT Cycle Length (ms)
N=
2
6
11
12
31
28
51
75
60
8

Other FVT Endpoints

		ATP Arm	Shock Arm	p
Acceleration (≥10% ↓ in CL)		n=4 2%	n=2 1%	NS
Syncope FVT		n= 2 0.7%	n=1 0.7%	NS
Mortality	Total	32 (10%)	24 (7%)	NS
	Sudden Cardiac	1 (0.3%)	2 (0.6%)	NS

Conclusions- PainFREE Rx II

1. A single empiric ATP attempt terminated 72% (adjusted) of Fast VTs.

2. ATP did not increase negative outcomes in terms of acceleration, syncope and mortality.

3. Patients treated by ATP have improved QoL score as compared to patients treated with shock.

4. Investigators of the PainFREE Rx II trial recommend ATP as the preferred therapy for FVT in most ICD patients.

Wathen MS, et al. Prospective randomized multicenter trial of empirical antitachycardia pacing versus shocks for spontaneous rapid ventricular tachycardia in patients with implantable cardioverter defibrillators:

PainFREE Rx II Trial Results. *Circulation* 2004;110:2591-2596.

MADIT RIT Moss AJ et al N Engl J Med. 2012 Dec 13;367(24):2275-83

Reduction in Inappropriate Therapy and Mortality through ICD Programming

BACKGROUND

The implantable cardioverter–defibrillator (ICD) is highly effective in reducing mortality among patients at risk for fatal arrhythmias, but inappropriate ICD activations are frequent, with potential adverse effects.

METHODS

We randomly assigned 1500 patients with a primary-prevention indication to receive an ICD with one of three programming configurations. The primary objective was to determine whether programmed high-rate therapy (with a 2.5-second delay before the initiation of therapy at a heart rate of ≥200 beats per minute) or delayed therapy (with a 60-second delay at 170 to 199 beats per minute, a 12-second delay at 200 to 249 beats per minute, and a 2.5-second delay at ≥250 beats per minute) was associated with a decrease in the number of patients with a first occurrence of inappropriate antitachycardia pacing or shocks, as compared with conventional programming (with a 2.5-second delay at 170 to 199 beats per minute and a 1.0-second delay at ≥200 beats per minute).

RESULTS

During an average follow-up of 1.4 years, high-rate therapy and delayed ICD therapy, as compared with conventional device programming, were associated with reductions in a first occurrence of inappropriate therapy (hazard ratio with high-rate therapy vs. conventional therapy, 0.21; 95% confidence interval [CI], 0.13 to 0.34; P<0.001; hazard ratio with delayed therapy vs. conventional therapy, 0.24; 95% CI, 0.15 to 0.40; P<0.001) and reductions in all-cause mortality (hazard ratio with high-rate therapy vs. conventional therapy, 0.45; 95% CI, 0.24 to 0.85; P=0.01; hazard ratio with delayed therapy vs. conventional therapy, 0.56; 95% CI, 0.30 to 1.02; P=0.06). There were no significant differences in procedure-related adverse events among the three treatment groups.

CONCLUSIONS

Programming of ICD therapies for tachyarrhythmias of 200 beats per minute or higher or with a prolonged delay in therapy at 170 beats per minute or higher, as compared with conventional programming, was associated with reductions in inappropriate therapy and all-cause mortality during long-term follow-up. (Funded by Boston Scientific; MADIT-RIT ClinicalTrials.gov number, NCT00947310.)

MADIT RIT

- 1500 patients with a primary-prevention ICD with one of three programming with Average follow-up of 1.4 years configurations:
  - High-rate therapy (2.5-second delay before the initiation of therapy at a heart rate of ≥200 beats/minute.
  - Delayed therapy -60-second delay at 170 to 199 beats per minute, a 12-second delay at 200 to 249 beats per minute, and a 2.5-second delay at ≥250 beats.
  - Conventional programming (with a 2.5-second delay at 170 to 199 beats per minute and a 1.0-second delay at ≥200 beats.
- Results: high-rate therapy and delayed ICD therapy, as compared with conventional device programming, were associated with reductions in a first occurrence of inappropriate therapy
  - HR high-rate therapy vs. conventional therapy, 0.21; CI, 0.13 to 0.34; P<0.001;
  - HR with delayed therapy vs. conventional therapy, 0.24; CI, 0.15 to 0.40; P<0.001).
- Reductions in all-cause mortality:

  HR high-rate therapy vs. conventional therapy, 0.45; CI, 0.24 to 0.85; P=0.01;

  HR delayed therapy vs. conventional therapy, 0.56; CI, 0.30 to 1.02; P=0.06
- There were no significant differences in procedure-related adverse events among the three treatment groups.

- **CONCLUSIONS: Programming** of ICD therapies for tachyarrhythmias of > 200 beats or prolonged delay in therapy at 170 beats per minute or higher, compared with conventional programming, was associated with reductions in inappropriate therapy and all-cause mortality during long-term follow-up

Moss AJ et al N Engl J Med. 2012 Dec 13;367(24):2275-83

1st And Total Occurrence Of Therapy – Main Difference In ATP In Conventional Arm

Table 2. First Occurrence, Any Occurrence, and Total Occurrences of Appropriate and Inappropriate Device Therapy According to Treatment Group.*

Variable	Conventional Therapy (N=514)	High-Rate Therapy (N=500)	Delayed Therapy (N=486)	P Value for High-Rate Therapy vs. Conventional Therapy	P Value for Delayed Therapy vs. Conventional Therapy
First occurrence of therapy — no. of patients (%)					
Appropriate therapy	114 (22)	45 (9)	27 (6)	<0.001	<0.001
Shock	20 (4)	22 (4)	17 (3)	0.68	0.74
Antitachycardia pacing	94 (18)	23 (5)	10 (2)	<0.001	<0.001
Inappropriate therapy	105 (20)	21 (4)	26 (5)	<0.001	<0.001
Shock	20 (4)	11 (2)	13 (3)	0.12	0.28
Antitachycardia pacing	85 (17)	10 (2)	13 (3)	<0.001	<0.001
Any occurrence of therapy — no. of patients (%)					
Appropriate therapy					
Shock	28 (5)	26 (5)	19 (4)	0.86	0.25
Antitachycardia pacing	111 (22)	38 (8)	20 (4)	<0.001	<0.001
Inappropriate therapy					
Shock	31 (6)	14 (3)	15 (3)	0.01	0.03
Antitachycardia pacing	104 (20)	20 (4)	25 (5)	<0.001	<0.001
Total occurrences of therapy — no. of occurrences					
Appropriate therapy	517	185	106	<0.001	<0.001
Shock	71	72	53	0.35	0.15
Antitachycardia pacing	446	113	143	<0.001	<0.001
Inappropriate therapy	998	75	264	<0.001	<0.001
Shock	105	25	49	0.001	0.16
Antitachycardia pacing	893	50	215	<0.001	<0.001

* Crude rates of the first occurrence of therapy and any occurrence of therapy were compared with the use of chi-square tests, and mean counts of total occurrences of therapy were compared with the use of negative binomial regression models.

Cumulative Probability Of 1st Inappropriate Therapy.

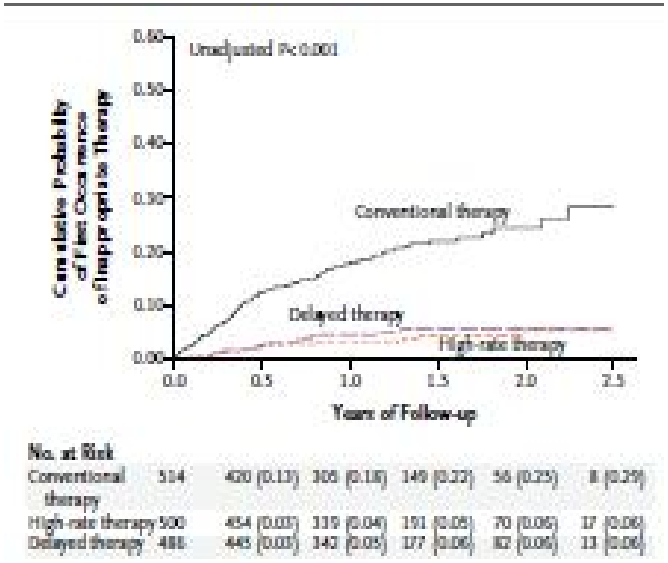


Figure 1. Cumulative Probability of First Occurrence of Inappropriate Therapy According to Treatment Group.

The values in parentheses are Kaplan–Meier estimates of the cumulative probability of a first occurrence of inappropriate device-delivered therapy in patients randomly assigned to therapy programmed for delivery at a heart rate of 170 beats per minute or higher (conventional therapy), at a heart rate of 200 beats per minute or higher (high-rate therapy), or at a heart rate of 170 beats per minute or higher with longer tachyarrhythmia monitoring (delayed therapy).

Cumulative Probability Of Death

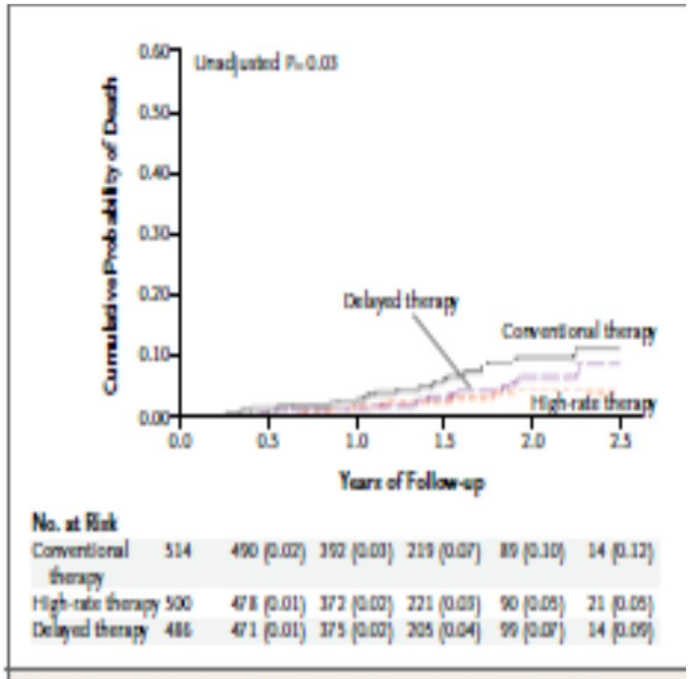


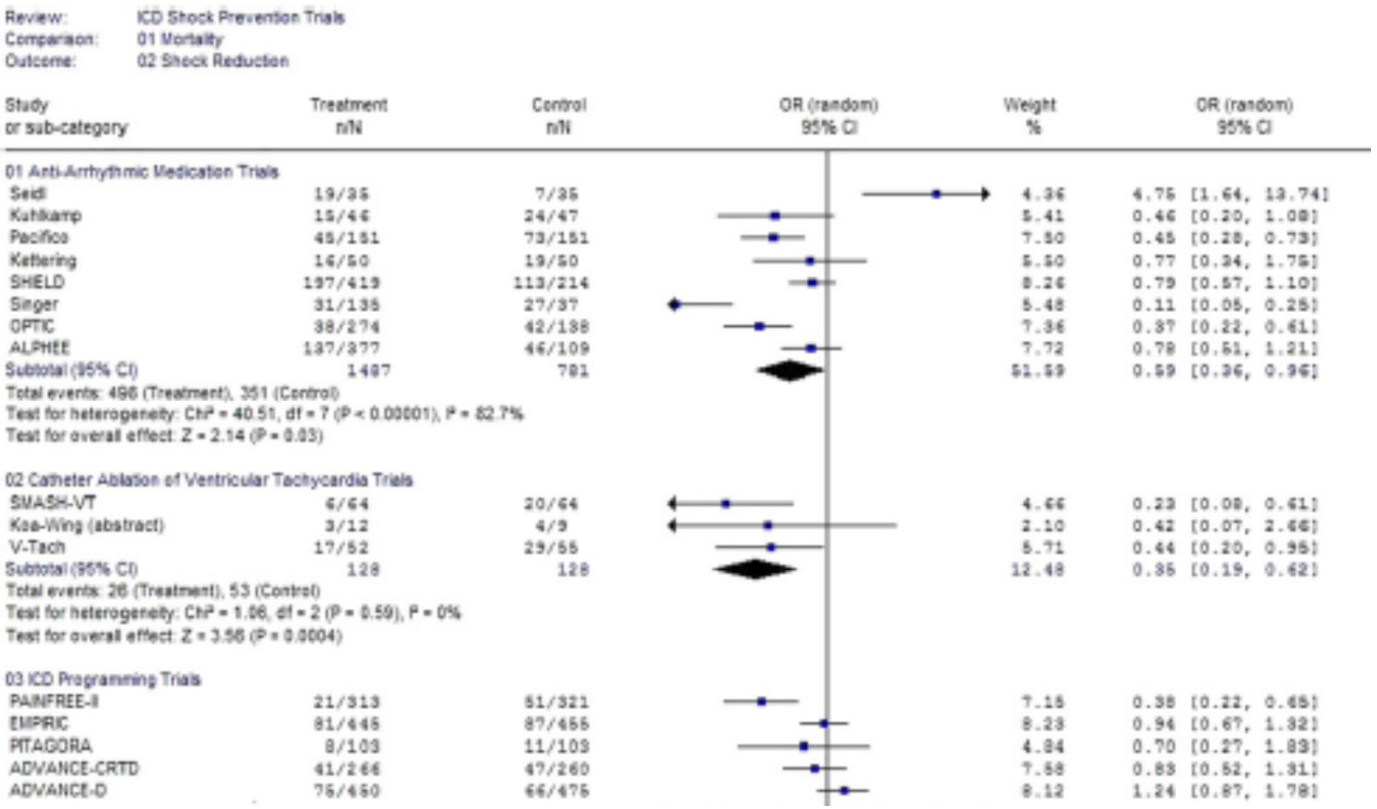
Figure 2. Cumulative Probability of Death According to Treatment Group.

The values in parentheses are Kaplan–Meier estimates of the cumulative probability of death.

Table 3. Hazard Ratios for a First Occurrence of Inappropriate Therapy, Death, and a First Episode of Syncope According to Treatment Group.

Variable	Conventional Therapy (N=514)	High-Rate Therapy (N=500)	Delayed Therapy (N=486)	High-Rate Therapy vs. Conventional Therapy		Delayed Therapy vs. Conventional Therapy	
				Hazard Ratio (95% CI)	P Value	Hazard Ratio (95% CI)	P Value
	no. of patients						
First occurrence of inappropriate therapy	105	21	26	0.21 (0.13–0.34)	<0.001	0.24 (0.15–0.40)	<0.001
Death	34	16	21	0.45 (0.24–0.85)	0.01	0.56 (0.30–1.02)	0.06
First episode of syncope	23	22	22	1.32 (0.71–2.47)	0.39	1.09 (0.58–2.05)	0.80

Number Of Patients Receiving Shocks Preventive Rx Vs. Placebo



Implantable cardioverter-**defibrillator shock** prevention does not reduce mortality: A systemic review.
Ha AH, Ham I, Nair GM, Connolly SJ, Dorian P, Morillo CA, Healey JS. Heart Rhythm.2012 ;12:2068-2074.

Does Shock Reduction Improve Survival

CONTEMPORARY REVIEW

Implantable cardioverter-defibrillator shock prevention does not reduce mortality: A systemic review

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BACKGROUND Mortality is increased among implantable cardioverter-defibrillator (ICD) recipients who receive shocks; however, whether shocks cause this increase or are simply a marker of risk is unknown. Antiarrhythmic medications, catheter ablation, and enhanced ICD programming all may reduce ICD shocks, but whether shock reduction decreases mortality is unknown.

OBJECTIVE The purpose of this study was to conduct a meta-analysis to estimate the impact of ICD shock reduction on survival.

METHODS Two independent reviewers searched MEDLINE, EMBASE, and clinicaltrials.gov and extracted data from randomized controlled trials assessing the efficacy of interventions to prevent ICD shocks.

RESULTS Seventeen randomized trials were included in this analysis, including 5875 patients. Mean ejection fraction of all trial participants was 32%, and 25% of the patients received ICD therapy for primary prophylaxis. Antiarrhythmic medications (odds ratio [OR] 0.59, 95% confidence interval [CI] 0.36–0.96, $P = .03$) and catheter ablation of ventricular tachycardia (OR 0.35, 95% CI 0.19–0.62, $P = .0004$) significantly reduced the proportion of patients receiving shocks. However, there was no significant reduction in mortality among trials of antiarrhythmic medications (OR 1.07, 95% CI 0.72–1.59, $P = .73$) or catheter ablation (OR 0.72, 95% CI 0.32–1.64, $P = .44$). The 5 ICD programming trials had sufficiently heterogeneous interventions that pooling of their results was not performed. However, only the PAINFREE-II (Pacing Fast Ventricular Tachycardia Reduces Shock Therapies) trial demonstrated a significant reduction in shocks (OR 0.38, 95% CI 0.22–0.65), but this was not associated with any significant reduction in mortality (OR 1.41, 95% CI 0.81–2.45).

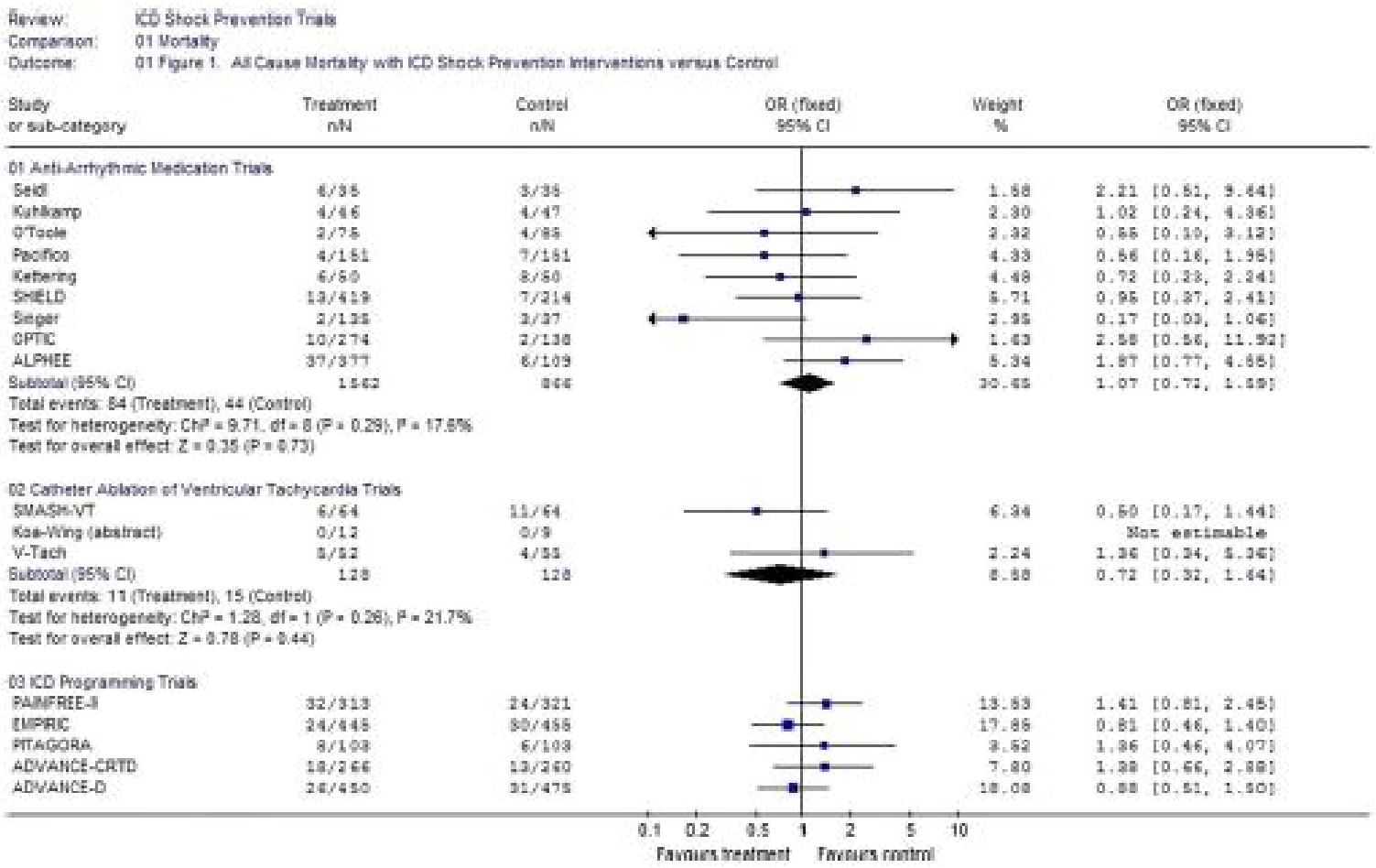
CONCLUSION There is no compelling evidence that existing interventions that reduce ICD shocks significantly improve survival.

KEYWORDS Implantable cardioverter defibrillator; Mortality; Prevention; Shock

ABBREVIATIONS **ATP** = antitachycardia pacing; **CI** = confidence interval; **ICD** = implantable cardioverter-defibrillator; **OR** = odds ratio; **VT** = ventricular tachycardia

(Heart Rhythm 2012;9:2068–2074)

All Cause Mortality In Trials Treatment VS Placebo



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Summary

- A significant number of clinical arrhythmias self terminate.
- Patients who receive ICD shocks have a worse prognosis.
- Intelligent programming reduces Inappropriate and appropriate DC.
- Shock prevention has morbidity & QOL implications but not necessarily mortality effect.
- Use of programmable technology facilates better programming, and reduces device shocks, Specifically:
  - Faster minimal detection rates. (> 200)
  - Longer waiting time before device activated treatment.
  - Use of ATP in all zones prior to shock down to 250-270 ms cl.
  - Remote monitoring to detect hardware failure earlier and avoid inappropriate therapy?.
- MADIT RIT – “Think before you act” is valid also for defibrillators.