Ηλεκτρική Θύελλα

Κων/νος Π. Πολυμερόπουλος, FESC, FACC

Δρ Ιατρικής ΑΠΘ

Επιμελητής Β`, Εργαστήριο Ηλεκτροφυσιολογίας και Βηματοδότησης,

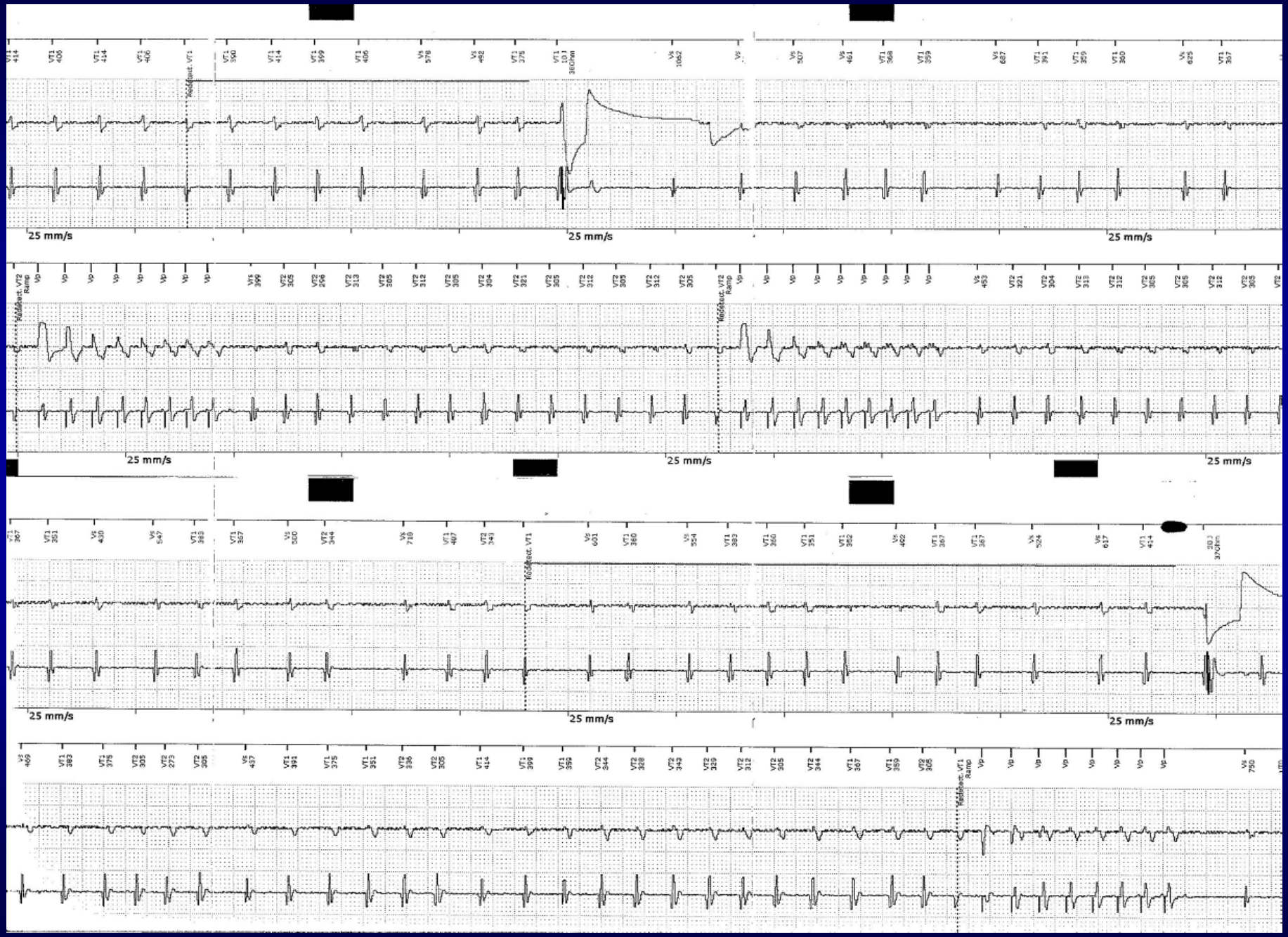
Α` Καρδιολογική Κλινική, Γ.Ν.Θ. «Γ. Παπανικολάου»

- *Frequent, recurrent* ventricular fibrillation (VF) & / or unstable ventricular tachycardia (VT)
- ≥ 3 appropriate shocks for VT / VF over 24 hours
- **≥ 3 episodes of appropriately treated VT or VF within 24 hours (ATP or shocks)**

Can J Cardiol **1996**;12:3B-8B
JACC **1998**;32:1909-15
Circulation **2001**;103:2066-71
JCE **2004**;15:1265-70
AHJ **2008**;156:847-5

Circulation **1996**;93:753-62
Europace **2000**;2:263-9
AJC **2006**;97:389-92
Eur Heart J **2006**;27:700-7
Int J Cardiol **2009** (poi)

ES reflects an episode of enhanced electrical instability that can occur at any time in ICD recipients


25 mm/s
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BIOTRONIK
ICS 3000 SW 1001.A/1

Patient:
Implant: **Lexos VR**
S/N: **79858115**

Shocks

Date: **01/05/2011**
Time: **19:25**

No.	Date/Time	Energy [J]	Charge time [s]	Imped. [Ω]	Remark
43	01.05.2011 16:11	15	4.5	40	
42	01.05.2011 16:11	15	4.5	40	
41	01.05.2011 16:10	15	4.5	40	
40	01.05.2011 16:10	15	4.5	40	
39	01.05.2011 16:09	15	4.5	40	
38	01.05.2011 16:09	15	4.5	40	
37	01.05.2011 16:08	30	9.3	39	
36	01.05.2011 16:08	15	4.5	40	
35	01.05.2011 16:07	30	6.6	***	Sync. Abort
34	01.05.2011 16:06	15	4.5	40	
33	01.05.2011 16:06	30	9.3	39	
32	01.05.2011 16:05	15	4.5	39	
31	01.05.2011 16:05	15	4.4	40	
30	01.05.2011 16:04	15	4.4	40	
29	01.05.2011 16:04	15	4.5	40	
28	01.05.2011 16:03	30	9.1	39	
27	01.05.2011 16:03	15	4.5	41	
26	01.05.2011 16:03	30	9.1	40	
25	01.05.2011 16:02	30	9.1	39	
24	01.05.2011 16:02	30	9.0	40	
23	01.05.2011 16:02	30	9.1	40	
22	01.05.2011 16:01	15	4.4	41	
21	01.05.2011 16:01	10	3.0	42	
20	01.05.2011 16:01	30	9.0	40	
19	01.05.2011 16:01	30	9.0	39	
18	01.05.2011 16:00	30	9.0	39	
17	01.05.2011 16:00	30	9.0	39	
16	01.05.2011 16:00	30	9.1	39	
15	01.05.2011 16:00	15	4.4	40	
14	01.05.2011 15:59	15	4.4	39	
13	01.05.2011 15:57	30	9.6	39	
12	01.05.2011 15:57	15	4.4	40	
11	01.05.2011 15:56	20	5.9	37	
10	01.05.2011 15:56	10	3.1	38	
9	23.03.2011 00:00	30	10.1	***	automatic reform

33 Shock-
15 min

[redacted], Georgia ICS 3000 SW 1001.A/1

Implant: **Lexos DR**
S/N: **79814184**

[redacted]

Episode List

Date: **12/11/2010**
Time: **14:51**

No.	Date/Time	Remark
278	11.11.10 21:13:35	VT2 1 ATP
277	11.11.10 20:56:24	VT2 1 ATP
276	11.11.10 20:55:58	VT2 1 ATP
275	11.11.10 20:55:34	VT2 1 ATP
274	11.11.10 20:55:10	VT2 1 ATP
273	11.11.10 20:54:08	VT2 1 ATP
[redacted]72	11.11.10 20:52:41	VT2 1 ATP
[redacted]71	11.11.10 20:51:25	VT2 1 ATP
[redacted]70	11.11.10 20:04:04	VF 1 Shock
269	11.11.10 20:03:29	VF 1 Shock
268	11.11.10 20:02:46	VT2 1 ATP
267	11.11.10 20:01:09	VT2 1 Shock, 2 ATP's
266	11.11.10 20:00:43	VT2 1 ATP
265	11.11.10 20:00:16	VT2 1 ATP
264	11.11.10 20:00:59	VF
263	11.11.10 19:59:23	VT2 1 Shock, 1 ATP
262	11.11.10 19:58:48	VT2 1 ATP
261	11.11.10 19:57:33	VT2 1 Shock, 2 ATP's
260	11.11.10 19:57:11	VT2 1 ATP
259	11.11.10 19:56:07	VT2 1 ATP
258	10.11.10 18:24:18	VT1 1 ATP
257	03.11.10 19:36:33	VT1 1 ATP

18 ATP, 5 Shock – 75 min

HARALAMPOS
Device: Protecta DR D364DRG
Serial Number: PTF601591S

Date of Visit: 29-Apr-2011 10:35:55
SW009 Software Version 1.0 (4.1)

Arrhythmia Episode List

Arrhythmia Episode List: 28-Apr-2011 12:20:33 to 29-Apr-2011 10:35:55
All collected episodes.

Type	ATP Seq	Shocks	Success	ID#	Date	Time hh:mm	Duration hh:mm:ss	Avg bpm A/V
VT-NS				76	29-Apr-2011	10:19	:02	69/172
VT-NS				75	29-Apr-2011	10:19	:03	71/171
VT-NS				74	29-Apr-2011	10:08	:02	71/175
VT-NS				73	29-Apr-2011	10:08	:04	73/171
VT-NS				72	29-Apr-2011	10:08	:02	71/175
VT-NS				71	29-Apr-2011	10:08	:02	70/176
VT-NS				70	29-Apr-2011	10:06	:03	71/175
VT-NS				69	29-Apr-2011	10:04	:03	73/175
VT-NS				68	29-Apr-2011	10:04	:04	72/172
VT-NS				67	29-Apr-2011	10:03	:03	73/175
VT-NS				66	29-Apr-2011	10:03	:02	71/176
VT-NS				65	29-Apr-2011	10:01	:03	73/175
VT-NS				64	29-Apr-2011	09:59	:02	77/175
VT-NS				63	29-Apr-2011	09:58	:03	77/174
VT-NS				62	29-Apr-2011	09:51	:05	81/172
FVT	1		Yes	59	29-Apr-2011	09:47	:08	82/171

12 Shock, +ATP ~ 3 h

HARALAMPOS
Device: Protecta DR D364DRG
Serial Number: PTF601591S

Date of Visit: 29-Apr-2011 10:35:55
SW009 Software Version 1.0 (4.1)
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Arrhythmia Episode List

Type	ATP Seq	Shocks	Success	ID#	Date	Time hh:mm	Duration hh:mm:ss	Avg bpm A/V
FVT	3		Yes	58	29-Apr-2011	09:44	:27	82/182
FVT	2		Yes	57	29-Apr-2011	09:44	:19	79/182
FVT	1		Yes	56	29-Apr-2011	09:43	:08	82/171
FVT	4	18J,35J	Yes	55	29-Apr-2011	09:40	:01:19	90/182
FVT	4	18J	Yes	54	29-Apr-2011	09:39	:50	91/188
FVT	1		Yes	53	29-Apr-2011	09:37	:07	90/194
FVT	1		Yes	52	29-Apr-2011	09:37	:07	90/194
FVT	2		Yes	51	29-Apr-2011	09:37	:16	87/194
FVT	2		Yes	50	29-Apr-2011	09:36	:16	91/194
FVT	1		Yes	49	29-Apr-2011	09:35	:07	120/194
FVT	2		Yes	48	29-Apr-2011	09:35	:19	90/188
FVT	3	20J	Yes	47	29-Apr-2011	09:33	:33	83/194
FVT	2		Yes	46	29-Apr-2011	09:31	:16	80/194
FVT	2		Yes	45	29-Apr-2011	09:30	:20	90/194
FVT	1		Yes	44	29-Apr-2011	09:29	:07	88/200
FVT	3		Yes	43	29-Apr-2011	09:28	:27	98/194
FVT	2		Yes	42	29-Apr-2011	09:28	:17	88/194
FVT	2		Yes	41	29-Apr-2011	09:27	:16	90/194
FVT	1		Yes	40	29-Apr-2011	09:27	:09	92/188
FVT	1		Yes	39	29-Apr-2011	09:27	:07	91/182

HARALAMPOS
Device: Protecta DR D364DRG
Serial Number: PTF601591S

Date of Visit: 29-Apr-2011 10:35:55
SW009 Software Version 1.0 (4.1)
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Arrhythmia Episode List

Type	ATP Seq	Shocks	Success	ID#	Date	Time hh:mm	Duration hh:mm:ss	Avg bpm A/V
FVT	4	20J	Yes	38	29-Apr-2011	09:25	:45	105/194
FVT	1		Yes	37	29-Apr-2011	09:25	:07	154/194
FVT	1		Yes	36	29-Apr-2011	09:25	:07	91/200
FVT	2		Yes	35	29-Apr-2011	09:24	:15	120/200
FVT	3		Yes	34	29-Apr-2011	09:23	:25	92/194
FVT	1		Yes	33	29-Apr-2011	09:23	:07	90/194
FVT	3		Yes	32	29-Apr-2011	09:22	:26	90/194
FVT	1		Yes	31	29-Apr-2011	09:22	:07	90/188
FVT	3		Yes	30	29-Apr-2011	09:22	:24	154/182
FVT	4	18J	Yes	29	29-Apr-2011	09:21	:54	85/188
FVT	1		Yes	28	29-Apr-2011	09:20	:07	98/194
FVT	4	18J	Yes	27	29-Apr-2011	09:19	:37	115/194
FVT	3		Yes	26	29-Apr-2011	09:18	:26	111/182
FVT	4	20J	Yes	25	29-Apr-2011	09:16	:35	82/194
FVT	1		Yes	24	29-Apr-2011	09:16	:07	109/200
FVT	1		Yes	23	29-Apr-2011	09:15	:06	92/194
FVT	1		Yes	22	29-Apr-2011	09:14	:10	90/194
FVT	2		Yes	21	29-Apr-2011	09:14	:16	88/176
FVT	5	20J,18J	Yes	20	29-Apr-2011	09:12	:01:16	86/194
FVT	2		Yes	19	29-Apr-2011	09:12	:16	76/194

HARALAMPOS
Device: Protecta DR D364DRG
Serial Number: PTF601591S

Date of Visit: 29-Apr-2011 10:35:55
SW009 Software Version 1.0 (4.1)
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Arrhythmia Episode List

Type	ATP Seq	Shocks	Success	ID#	Date	Time hh:mm	Duration hh:mm:ss	Avg bpm A/V
FVT	3		Yes	18	29-Apr-2011	09:11	:28	86/194
FVT	2		Yes	17	29-Apr-2011	09:11	:15	81/194
FVT	1		Yes	16	29-Apr-2011	09:09	:07	86/188
FVT	2		Yes	15	29-Apr-2011	09:08	:19	87/182
VT	4		Yes	14	29-Apr-2011	09:08	:44	94/167
VT	1		Yes	13	29-Apr-2011	09:07	:08	91/167
FVT	4	18J,35J	Yes	12	29-Apr-2011	09:06	:01:23	98/200
FVT	1		Yes	11	29-Apr-2011	09:06	:06	100/194
FVT	2		Yes	10	29-Apr-2011	09:05	:17	102/194
FVT	1		Yes	9	29-Apr-2011	09:05	:07	103/188
FVT	1		Yes	8	29-Apr-2011	09:05	:07	100/194
FVT	1		Yes	7	29-Apr-2011	09:04	:07	133/194
FVT	2		Yes	6	29-Apr-2011	09:04	:16	94/194
FVT	1		Yes	5	29-Apr-2011	09:03	:07	98/194
FVT	1		Yes	2	29-Apr-2011	06:56	:07	102/182

Last Programmer Session 28-Apr-2011

(Data prior to last session has not been interrogated.)

VASSILIOS
ICD Model: Maximo DR 7278
Serial Number: PRM623172S

May 16, 2011 09:20:21
9978 Software Version 7.0
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VT/VF Episode List Report

83 episodes, 4 shock ~ 7h

Last Interrogation: May 16, 2011 09:16:26
Episodes Last Cleared: Jan 19, 2010 10:32:30

ID#	Date/Time	Type	V. Cycle	Last Rx	Success	Duration
106	May 16 01:44:52	VT	330 ms	VT Rx 1	Yes	13 sec
105	May 16 01:43:44	VT	330 ms	VT Rx 1	Yes	13 sec
104	May 15 01:38:54	FVT	300 ms	FVT Rx 1	Yes	33 sec
103	May 15 00:21:02	FVT	300 ms	FVT Rx 1	Yes	16 sec
102	May 14 22:59:19	FVT	290 ms	FVT Rx 1	Yes	22 sec
101	May 14 22:59:00	FVT	290 ms	FVT Rx 1	Yes	6 sec
100	May 14 22:56:48	VF	290 ms	FVT Rx 1	Yes	1.1 min
99	May 14 22:50:41	FVT	300 ms	FVT Rx 1	Yes	7 sec
98	May 14 22:48:00	FVT	300 ms	FVT Rx 1	Yes	14 sec
97	May 14 22:43:00	FVT	300 ms	FVT Rx 1	Yes	39 sec
96	May 14 22:29:27	FVT	290 ms	FVT Rx 1	Yes	24 sec
95	May 14 22:26:46	FVT	290 ms	FVT Rx 1	Yes	34 sec
94	May 14 22:25:28	FVT	290 ms	FVT Rx 1	Yes	30 sec
93	May 14 22:11:58	FVT	290 ms	FVT Rx 1	Yes	7 sec
92	May 14 22:10:55	FVT	280 ms	VF Rx 1	Yes	43 sec
91	May 14 22:10:01	FVT	290 ms	FVT Rx 1	Yes	43 sec
90	May 14 22:08:11	FVT	290 ms	FVT Rx 1	Yes	8 sec
89	May 14 22:07:32	FVT	280 ms	FVT Rx 1	Yes	28 sec

VASSILIOS
ICD Model: Maximo DR 7278
Serial Number: PRM623172S

May 16, 2011 09:20:25
9978 Software Version 7.0
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VT/VF Episode List Report

ID#	Date/Time	Type	V. Cycle	Last Rx	Success	Duration
88	May 14 22:06:07	FVT	290 ms	FVT Rx 1	Yes	30 sec
87	May 14 22:05:07	FVT	300 ms	FVT Rx 1	Yes	10 sec
86	May 14 22:04:49	FVT	280 ms	FVT Rx 1	Yes	8 sec
85	May 14 22:03:45	FVT	280 ms	FVT Rx 1	Yes	24 sec
84	May 14 22:02:37	FVT	290 ms	FVT Rx 1	Yes	8 sec
83	May 14 22:02:21	FVT	280 ms	FVT Rx 1	Yes	8 sec
82	May 14 21:58:58	FVT	290 ms	FVT Rx 1	No	29 sec
81	May 14 21:57:58	FVT	300 ms	VF Rx 1	Yes	46 sec
80	May 14 21:57:44	FVT	290 ms	FVT Rx 1	Yes	7 sec
79	May 14 21:55:09	FVT	290 ms	FVT Rx 1	Yes	7 sec
78	May 14 21:54:54	FVT	290 ms	FVT Rx 1	Yes	7 sec
77	May 14 21:54:41	FVT	290 ms	FVT Rx 1	Yes	6 sec
76	May 14 21:54:24	VF	250 ms	VF Rx 1	Yes	7 sec
75	May 14 21:53:51	FVT	290 ms	FVT Rx 1	Yes	17 sec
74	May 14 21:52:04	FVT	290 ms	FVT Rx 1	Yes	51 sec
73	May 14 21:51:30	FVT	290 ms	FVT Rx 1	Yes	6 sec
72	May 14 21:50:08	FVT	290 ms	FVT Rx 1	Yes	6 sec
71	May 14 21:48:44	FVT	280 ms	FVT Rx 1	Yes	38 sec
70	May 14 21:47:24	FVT	290 ms	FVT Rx 1	Yes	8 sec
69	May 14 21:46:40	FVT	290 ms	FVT Rx 1	Yes	9 sec
68	May 14 21:45:00	FVT	300 ms	FVT Rx 1	Yes	29 sec
67	May 14 21:44:45	FVT	290 ms	FVT Rx 1	Yes	7 sec

VASSILIOS
ICD Model: Maximo DR 7278
Serial Number: PRM623172S

May 16, 2011 09:20:28
9978 Software Version 7.0
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VT/VF Episode List Report

ID#	Date/Time	Type	V. Cycle	Last Rx	Success	Duration
66	May 14 21:44:30	FVT	280 ms	FVT Rx 1	Yes	7 sec
65	May 14 21:42:33	FVT	290 ms	FVT Rx 1	Yes	9 sec
64	May 14 21:42:14	FVT	280 ms	FVT Rx 1	Yes	7 sec
63	May 14 21:40:30	FVT	280 ms	FVT Rx 1	Yes	46 sec
62	May 14 21:36:51	FVT	280 ms	VF Rx 1	Yes	37 sec
61	May 14 21:35:15	FVT	290 ms	FVT Rx 1	Yes	38 sec
60	May 14 21:33:09	FVT	290 ms	FVT Rx 1	Yes	8 sec
59	May 14 21:32:07	FVT	290 ms	FVT Rx 1	Yes	7 sec
58	May 14 21:29:05	FVT	290 ms	FVT Rx 1	Yes	24 sec
57	May 14 21:26:48	FVT	280 ms	VF Rx 2	Yes	1.9 min
56	May 14 21:24:19	FVT	290 ms	FVT Rx 1	Yes	16 sec
55	May 14 21:23:07	FVT	290 ms	FVT Rx 1	Yes	18 sec
54	May 14 21:22:54	FVT	290 ms	FVT Rx 1	Yes	7 sec
53	May 14 21:21:49	FVT	290 ms	FVT Rx 1	Yes	34 sec
52	May 14 21:21:23	FVT	290 ms	FVT Rx 1	Yes	6 sec
51	May 14 21:04:04	FVT	290 ms	FVT Rx 1	Yes	12 sec
50	May 14 21:03:46	FVT	280 ms	FVT Rx 1	Yes	7 sec
49	May 14 21:01:36	FVT	290 ms	FVT Rx 1	Yes	7 sec
48	May 14 21:01:20	FVT	280 ms	FVT Rx 1	Yes	6 sec
47	May 14 20:58:57	FVT	290 ms	FVT Rx 1	Yes	21 sec
46	May 14 20:58:40	FVT	280 ms	FVT Rx 1	Yes	7 sec
45	May 14 20:56:35	FVT	280 ms	FVT Rx 1	Yes	32 sec

VASSILIOS
ICD Model: Maximo DR 7278
Serial Number: PRM623172S

May 16, 2011 09:20:32
9978 Software Version 7.0
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VT/VF Episode List Report

ID#	Date/Time	Type	V. Cycle	Last Rx	Success	Duration
44	May 14 20:53:19	FVT	300 ms	FVT Rx 1	Yes	8 sec
43	May 14 20:53:01	FVT	290 ms	FVT Rx 1	Yes	10 sec
42	May 14 20:52:45	FVT	290 ms	FVT Rx 1	Yes	8 sec
41	May 14 20:52:27	FVT	290 ms	FVT Rx 1	Yes	7 sec
40	May 14 20:51:07	FVT	280 ms	FVT Rx 1	Yes	1.1 min
39	May 14 20:48:33	VF	280 ms	VF Rx 1	Yes	8 sec
38	May 14 20:44:47	FVT	290 ms	FVT Rx 1	Yes	8 sec
37	May 14 20:42:47	FVT	280 ms	FVT Rx 1	Yes	10 sec
36	May 14 20:38:30	FVT	290 ms	FVT Rx 1	Yes	23 sec
35	May 14 20:38:14	FVT	300 ms	FVT Rx 1	Yes	8 sec
34	May 14 20:35:07	FVT	270 ms	VF Rx 1	Yes	14 sec
33	May 14 20:31:53	FVT	280 ms	FVT Rx 1	Yes	9 sec
32	May 14 20:30:19	FVT	280 ms	FVT Rx 1	Yes	42 sec
31	May 14 20:09:36	FVT	280 ms	FVT Rx 1	Yes	26 sec
30	May 14 20:04:35	FVT	280 ms	FVT Rx 1	Yes	28 sec
29	May 14 20:03:42	FVT	290 ms	FVT Rx 1	Yes	9 sec
28	May 14 20:03:10	FVT	280 ms	FVT Rx 1	Yes	10 sec
27	May 14 20:02:39	FVT	280 ms	FVT Rx 1	Yes	13 sec
26	May 14 19:59:15	FVT	290 ms	FVT Rx 1	Yes	8 sec
25	May 14 19:57:45	FVT	290 ms	FVT Rx 1	Yes	42 sec
24	May 14 19:55:50	VF	280 ms	VF Rx 1	Yes	8 sec
23	May 14 19:54:53	FVT	290 ms	VF Rx 1	Yes	48 sec

Συχνότητα

	Year	N	F-up	Storm
Villacastin	1996	80	21 m	**25% in 3 years**
Credner	1998	103	14 m	
Exner	2001	457	31 m	**1 - 2% per month**
Verma	2004	2,028	14 m	
Brigadeau	2006	307	27 m	40%
Hohnloser	2006	633	12 m	23%
Sesselberg	2007	719	21 m	**0.2 - 0.4% per month**
Gasparini	2008	631	19 m	

Circulation **1996**;93:753; JACC **1998**;32:1909; Circulation **2001**;103:2066; JCE **2004**;15:1265; Eur Heart J **2006**;27:700; Eur Heart J **2006**; 27:3027; Heart Rhythm 2007;4:1395; AmHJ **2008**; 146:847.

	Time to ES	Therapies	Risk
Villacastin	---	Shocks	↑
Credner	4 mo	Shocks / ATP	↑
Exner	9 mo	Shocks / ATP	↑
Verma	27 mo	Shocks / ATP	↑
Brigadeau	< 6 mo	Shocks / ATP	←→
Hohnloser	3 mo	Shocks / ATP	↑
Sesselberg	4 mo	Shocks / ATP	↑
Gasparini	6 mo	Shocks / ATP	↑

Circulation **1996**;93:753; JACC **1998**;32:1909; Circulation **2001**;103:2066; JCE **2004**;15:1265; Eur Heart J **2006**;27:700; Eur Heart J **2006**; 27:3027; Heart Rhythm 2007;4:1395; AmHJ **2008;** 146:847.

Αρρυθμίες και ES

Author	ES Arrhythmias
Credner[18]	Pts: 64% mVT, 21% VF, 14% mVT+VF
Greene[19]	Eps: 97% mVT, 3% pVT+VF
Bänsch[15]	ES: 87% mVT, 8% pVT/VF, 4% different mVT
Exner[12]	Initial Eps: 86% mVT, 14% VF or VT+VF
Verma[23]	Pts: 52% mVT, 48% VF
Stuber[16]	ES: 93% mVT, 7% pVT
Hohnloser[20]	ES: 91% mVT, 8% mVT+VF, 1% VF
Brigadeau[39]	ES: 90% mVT, 8% VF, 2% pVT
Gatzoulis[40]	NA

VT is the most common cause

Προγνωστική Σημασία ;

- Is the electrical storm an independent predictor of adverse long-term outcome in ICD recipients?

Author	ES Prognosis
Kowey[10]	↓ (Mortality 13.6% in 48 hour)
Villacastin[5]	↓
Fries[9]	↓
Credner[18]	Ø
Nademanee[17]	↓ (1-year mortality 95% on AAD and 33% on β blocker)
Exner[12]	↓ (RR 2.4)
Greene[19]	Ø
Bänsch[15]	↓
Verma[23]	↓
Wood[7]	(Not analyzed)
Stuber[16]	↓: 5 year mortality 33 versus 13%
Hohnloser[20]	Ø
Arya[38]	NA
Brigadeau[39]	Ø
Gatzoulis[40]	↓: Mortality 53 versus 14% during 33 ± 26 months

1% άμεση θνητότητα

Electrical Storm in Patients with an Implanted Defibrillator: A Matter of Definition

Carsten W. Israel, M.D.* and S. Serge Barold, M.D., F.A.C.C., F.E.S.C.†

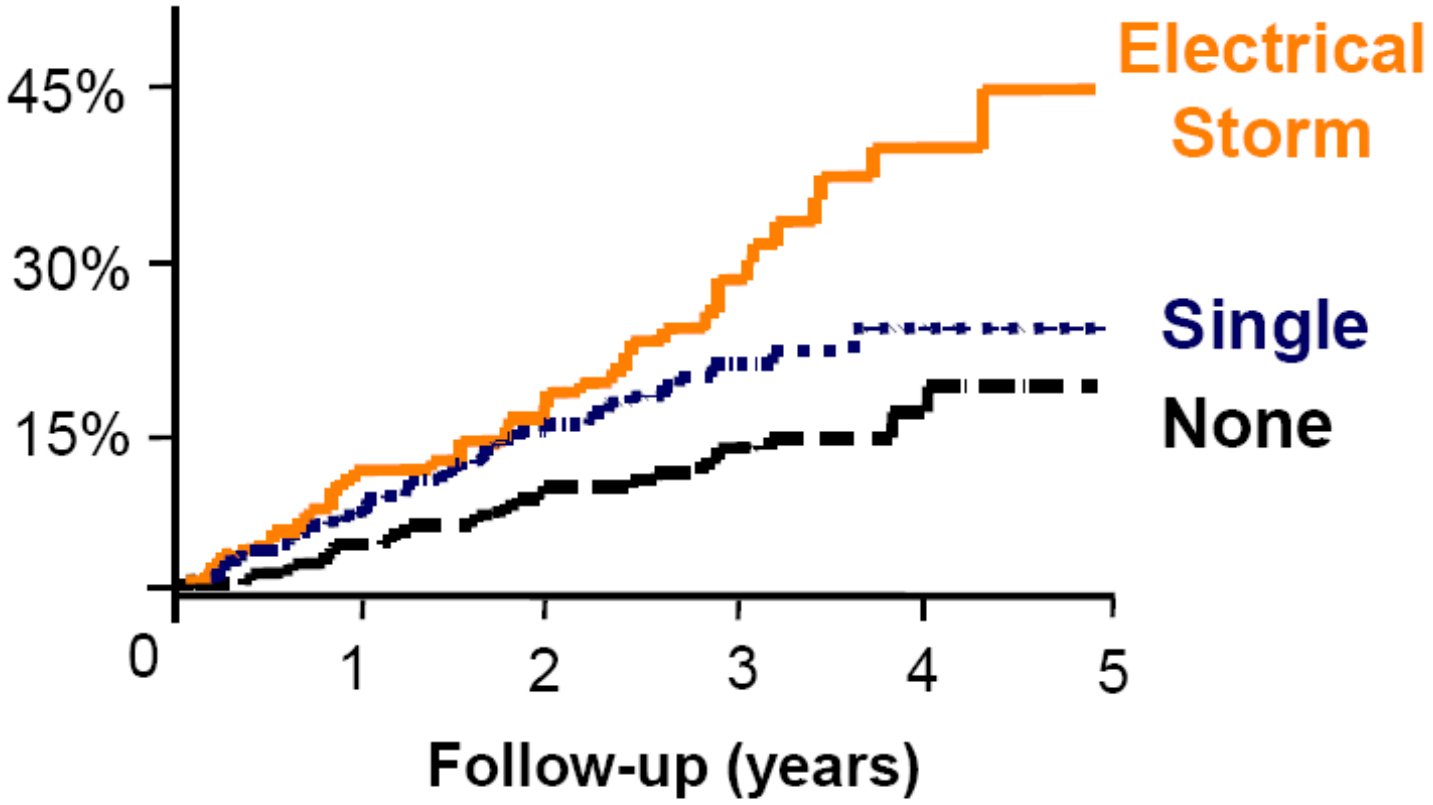
Author	ES Hospitalization
Credner[18]	86% of pts
Greene[19]	NA
Bänsch[15]	78% of ES, 50% for ≤3 shocks, 100% for >3 shocks
Exner[12]	NA
Verma[23]	NA
Stuber[16]	19% of eps
Hohnloser[20]	55% of pts (82% of pts in emergency room)
Brigadeau[39]	NA
Gatzoulis[40]	29/32 pts (91%)

50-80% νοσηλεία

Electrical Storm in Patients with an Implanted Defibrillator: A Matter of Definition

Carsten W. Israel, M.D.* and S. Serge Barold, M.D., F.A.C.C., F.E.S.C.†

AVID: All-cause Mortality



Exner et al. Circulation **2001**;103:2066-71

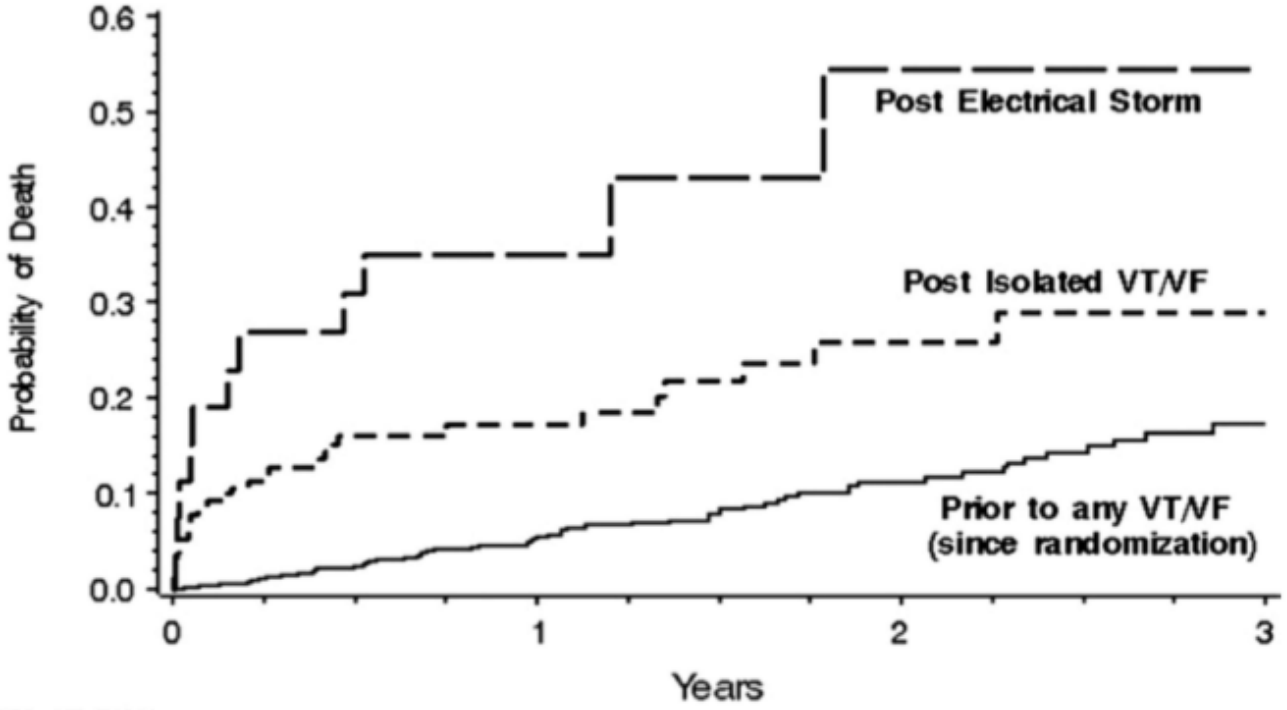
Predictors of Mortality: AVID

	Relative Risk (95% CI)
EF (per 0.10 increase)	0.7 (0.6 – 0.9) ***
Heart Failure	1.8 (1.2 – 2.6) **
Diabetes	1.9 (1.3 – 2.8) **
→ **Single ICD Therapy**	1.6 (1.1 – 2.5) *
→ **Electrical Storm**	**3.0 (2.0 – 4.6)** ***
1st 3 mo. Post-Storm	**5.6 (2.8 – 11.5)** ***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Exner et al. Circulation **2001**;103:2066-71

MADIT-II All-cause Mortality



PATIENTS AT RISK				
Electrical Storm	27	9 (0.35)	3 (0.55)	2 (0.55)
Isolated VT/VF	156	67 (0.17)	28 (0.26)	6 (0.29)
Prior to any VT/VF	719	419 (0.06)	206 (0.11)	75 (0.17)

Sesselberg et al. Heart Rhythm **2007**;4:1395–1402

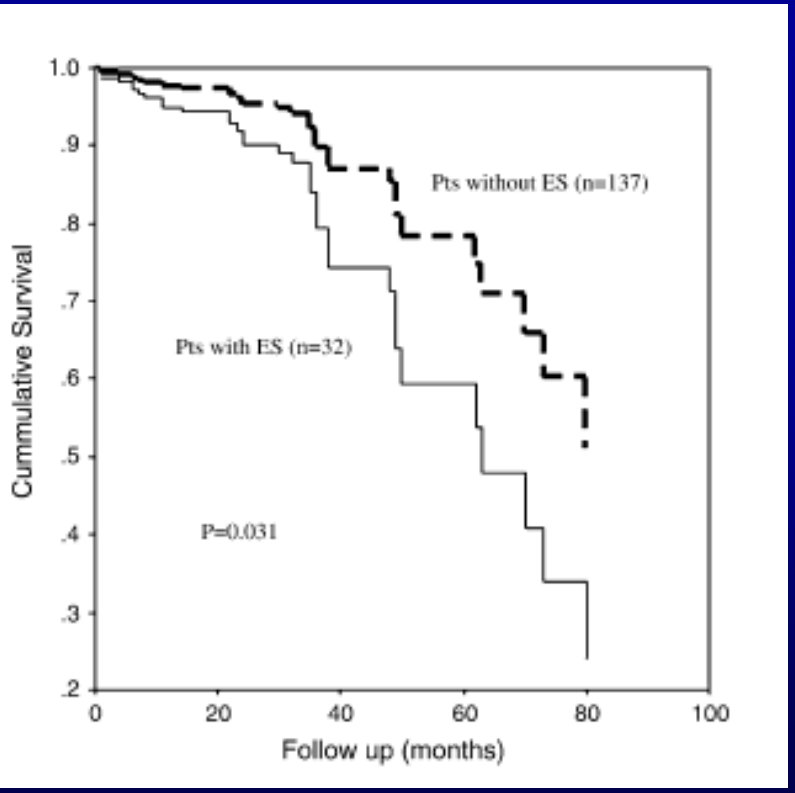
Table 3 Outcomes for patients who experience electrical storm and isolated VT/VF

Group	n	Hazard ratio	95% Confidence interval	*P* value
Effect of ES and isolated VT/VF on death*				
No episodes	550	1.0		
Isolated VT/VF	142	2.5	1.5–4.0	<.01
ES	27	7.4	3.8–14.4	<.01
≤3 months post ES	9	17.8	8.0–39.5	<.01
>3 months post ES	18	3.5	1.2–9.8	.02
Effect of ES and isolated VT/VF on CHF hospitalizations†				
No episodes		1.0		
Isolated VT/VF		1.5	0.9–2.3	.12
ES		2.3	0.8–6.3	.11
Effect of ES and isolated VT/VF on MI/angina‡				
No episodes		1.0		
Isolated VT/VF		1.2	0.6–2.2	.58
ES		4.5	1.8–11.4	<.01

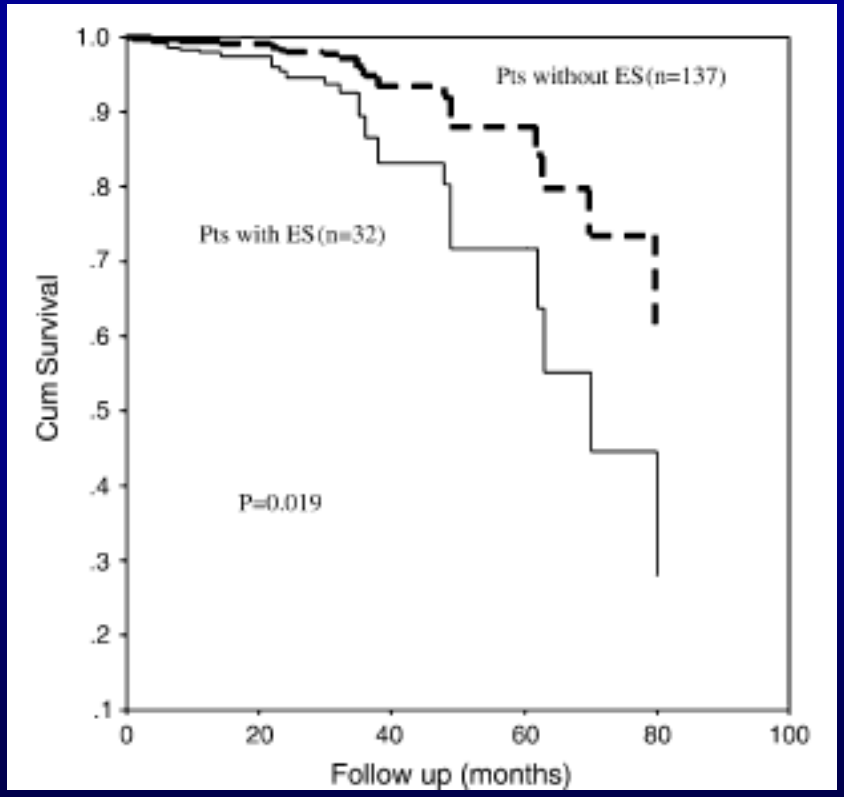
Electrical storm is an independent predictor of adverse long-term outcome in the era of implantable defibrillator therapy

Konstantinos A. Gatzoulis*, George K. Andrikopoulos, Theodoros Apostolopoulos, Elias Sotiropoulos, George Zervopoulos, John Antoniou, Stella Brili, Christodoulos I. Stefanadis

Total Mortality



Cardiac Mortality



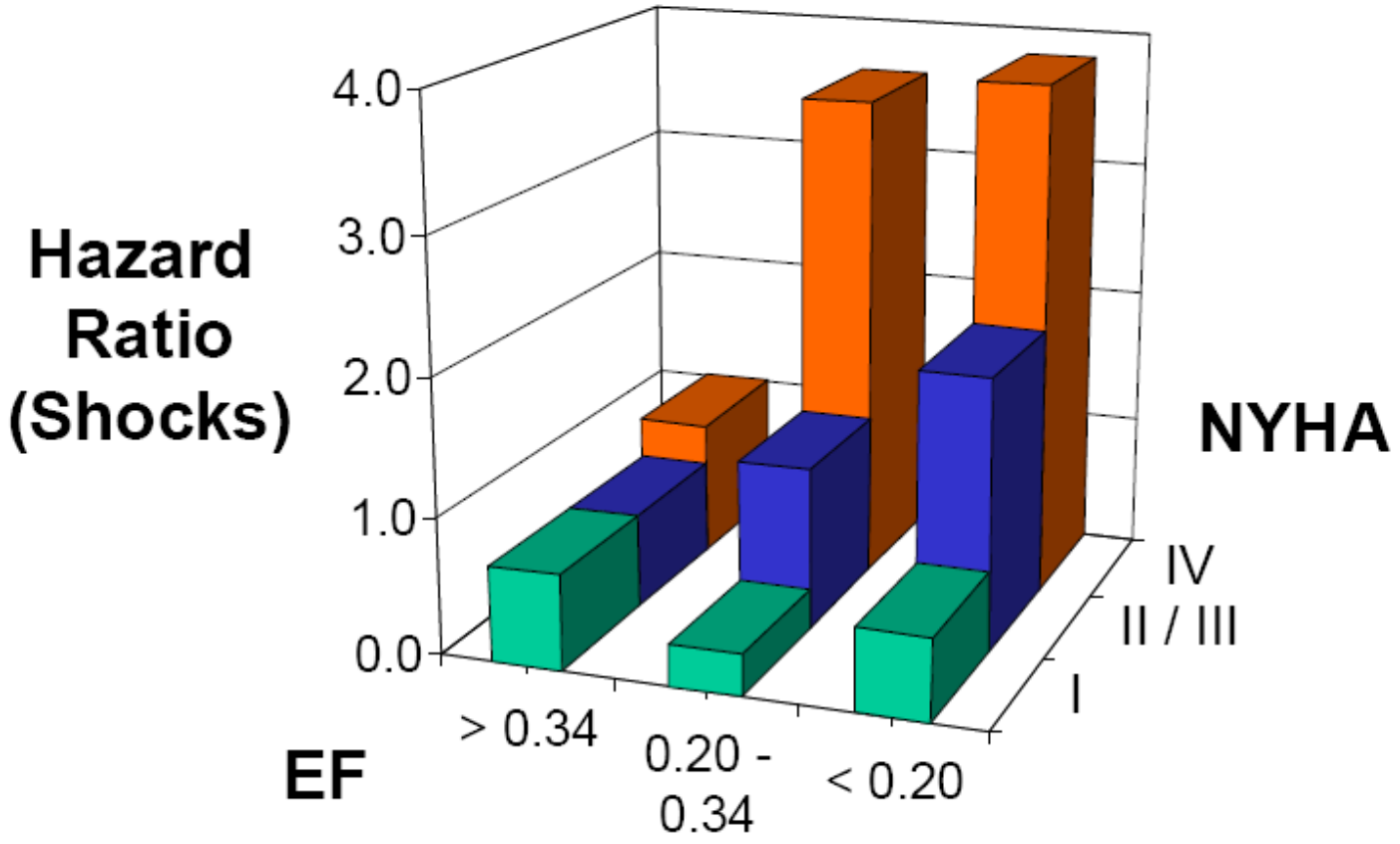
Europace (2005) 7, 184–192

Ηλεκτρική Θύελλα

Ασθενείς υψηλού κινδύνου?

Triggers Of Ventricular Arrhythmias

Interplay: EF & Functional Capacity



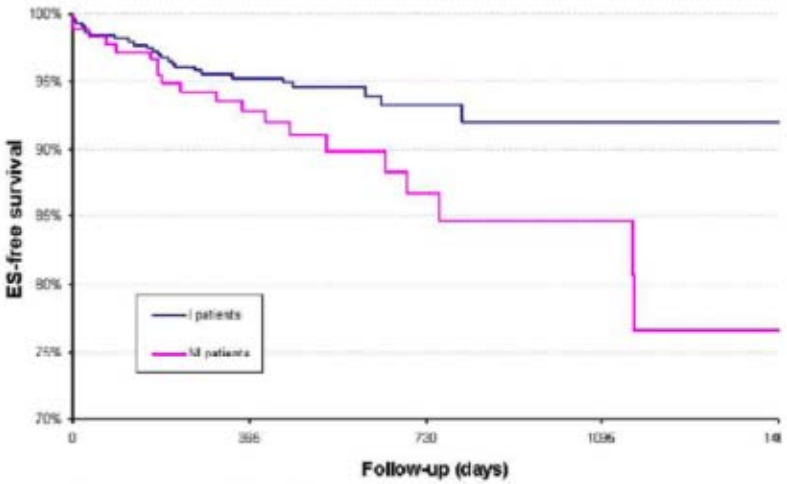
(TOVA) Study

Whang et al. Circulation **2004**;109:1386-91

InSync ICD Italian Registry

N = 631; LVEF 0.26; QRS 164; mostly NYHA III

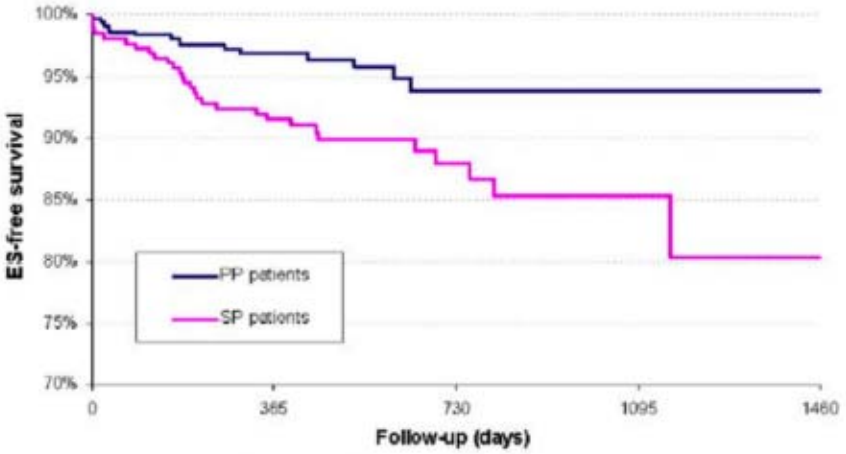
Ischemic etiology



Log-rank test *P* = .022

Adjusted HR 2.0; p = 0.025

Secondary prevention



Log-rank test *P* = .0021

Adjusted HR 2.3; p = 0.015

Gasparini et al. Am Heart J **2008**;156:847-54

Prevalence and Predictors of Electrical Storm in Patients With Implantable Cardioverter-Defibrillator

Arash Arya, MD*, Majid Haghjoo, MD, Mohammad Reza Dehghani, MD, Amir Farjam Fazelifar, MD, Mohammad-Hosein Nikoo, MD, Ataollah Bagherzadeh, MD, and Mohammad Ali Sadr-Ameli, MD

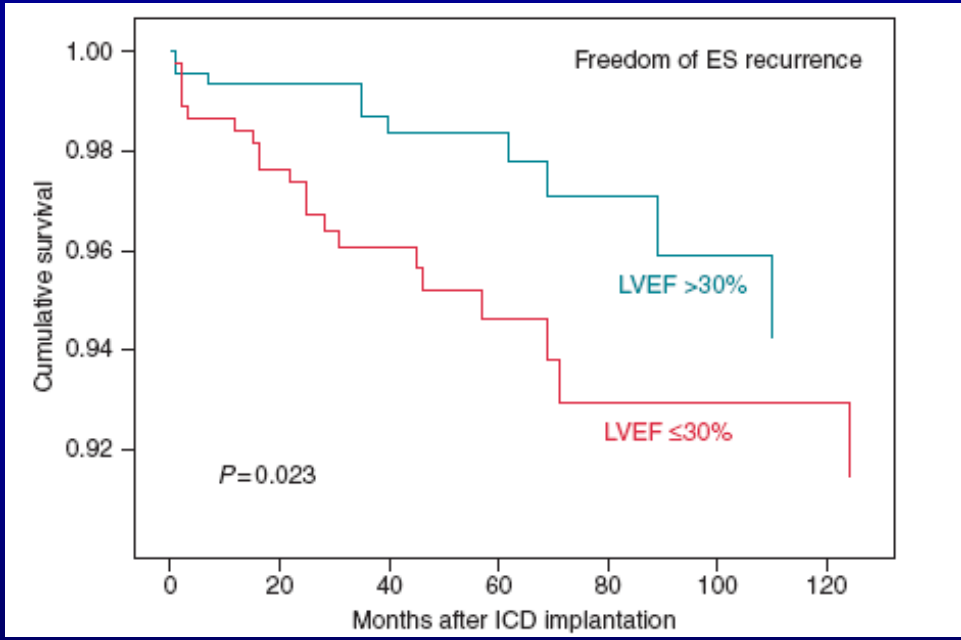
Predictors of electrical storm

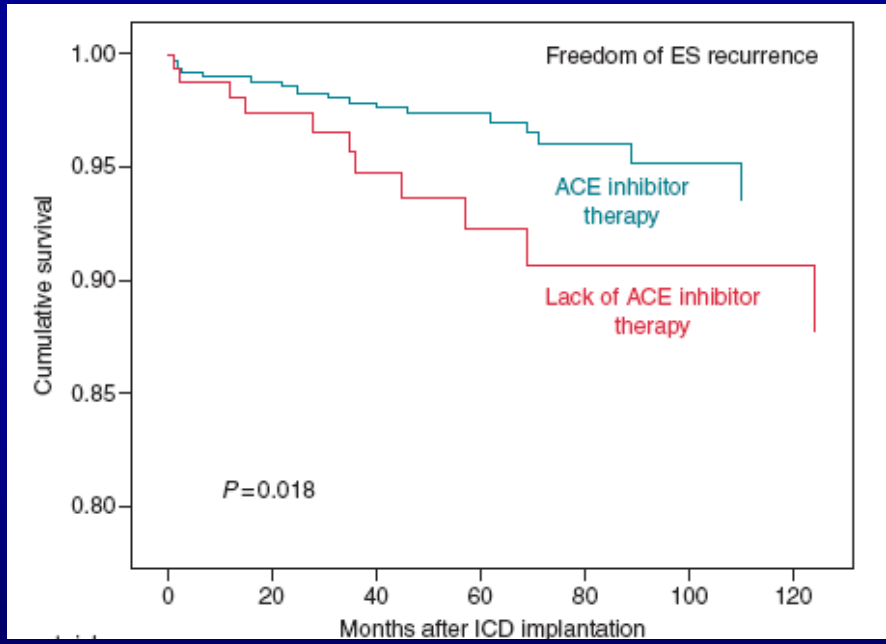
Variable	Odds Ratio	95% Confidence Interval	p Value†
QRS width ≥120 ms	5.87	2.0–16.8	0.001
Ejection fraction <25%	4.0	1.2–14.5	0.038
Lack of β-blocker therapy*	6.0	1.75–21.0	0.007
Lack of ACE inhibitor therapy*	6.12	1.47–25.5	0.017

(Am J Cardiol 2006;97:389–392)

Predictors of electrical storm recurrences in patients with implantable cardioverter-defibrillators

Florian Streitner[1*†], Juergen Kuschyk[1†], Christian Veltmann[1], Eva Mahl[1], Claudia Dietrich[1], Rainer Schimpf[1], Christina Doesch[1], Ines Streitner[1], Christian Wolpert[2], and Martin Borggrefe[1]





in 63 of 955 patients (6.6%)

Europace (2011) **13**, 668–674

Electrical Storm: Triggers

Ischemia / infarction	4 - 14%
Electrolyte / metabolic	4 - 10%
Heart Failure	9 - 19%
No clear cause	57 - 87%

JACC **1998**;32:1909-15
Eur Heart J **2006**;27:700-7

JCE **2004**;15:1265-70
Eur Heart J **2006**;27:3027-32

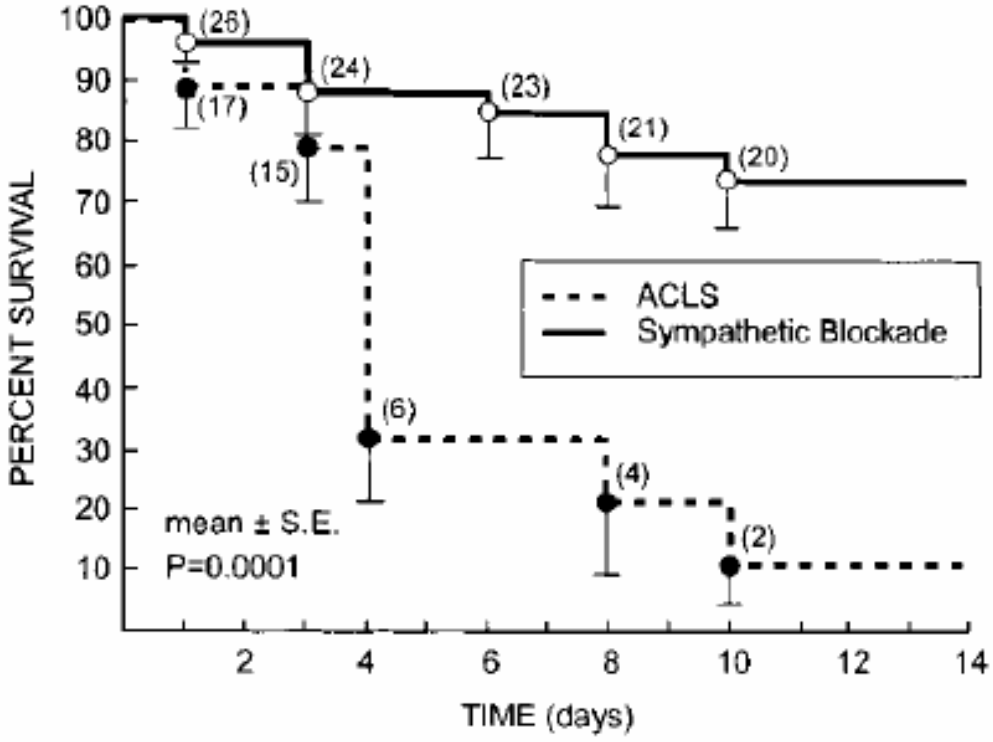
Θεραπεία

1. Αντιμετώπιση συμπαθητικοτονίας (β-αποκλειστές- βενζοδιαζεπίνη)
2. Αμιωδαρόνη, αντιαρρυθμικά
3. Αντιμετώπιση αναστρέψιμων αιτίων (διαταραχές ηλεκτρολυτών, ισχαιμία, καρδιακή ανεπάρκεια)
4. Ορθός προγραμματισμός ICD
5. RFA

Tx of ES: Sympathetic Blockade

N = 49; Recent MI (4 to 52 d)

- Observational
  - Frequent VT/VF
    - ≥ 20 / day
    - ≥ 4 / hour
  - LSG or aggressive beta-blockade
  - Usual ACLS



Nademanee et al. Circulation **2000**;102:742-7

Electrical Storm in Patients With Transvenous Implantable Cardioverter-Defibrillators

Incidence, Management and Prognostic Implications

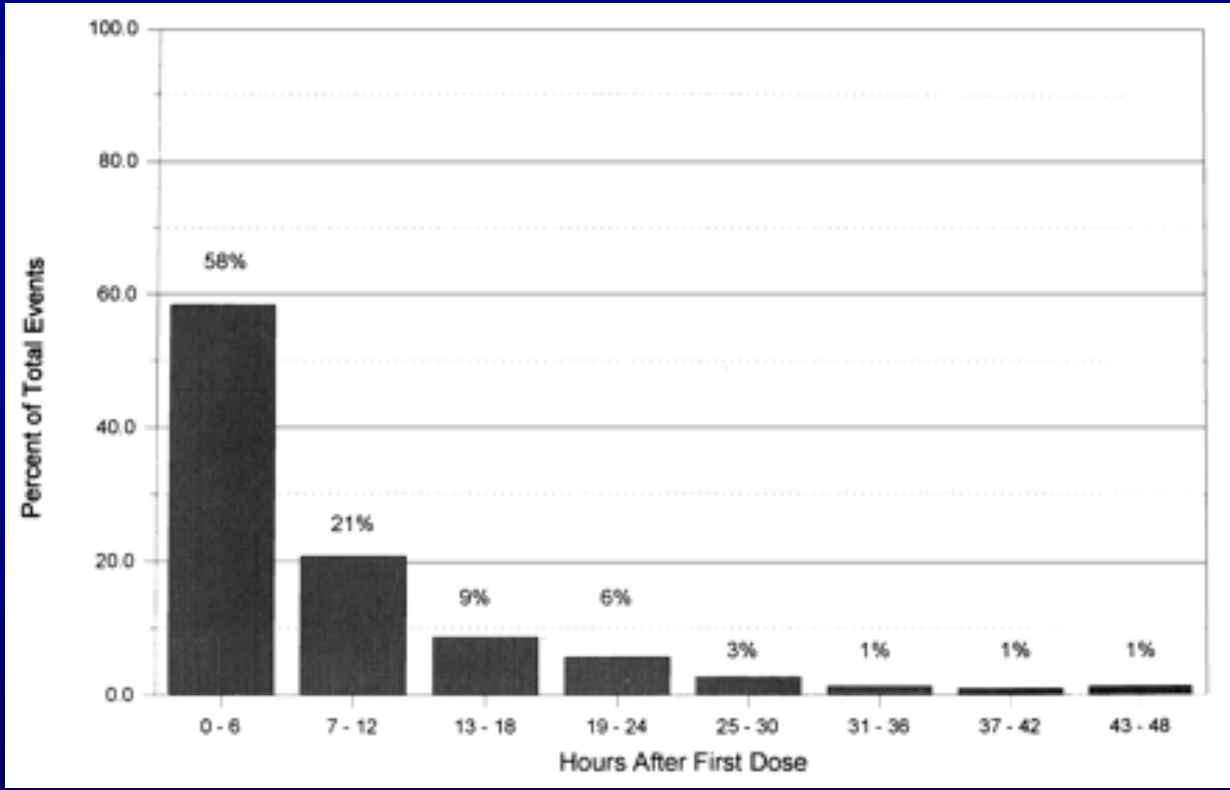
SUSANNE C. CREDNER, MD, THOMAS KLINGENHEBEN, MD, OLIVER MAUSS, PHD, CHRISTIAN STICHERLING, MD, STEFAN H. HOHNLOSER, MD, FACC

β-adrenergic blocking substances was initiated or intensified

Finally, when specific antiarrhythmic drug therapy was necessary due to recurrence of arrhythmic episodes (mean number of events constituting electrical storm was 17 ± 17), IV administration of amiodarone was initiated. Utilizing this drug regimen, the majority of patients could be stabilized within a relatively short period of time (median 3.5 h). This experience

(J Am Coll Cardiol 1998;32:1909–15)

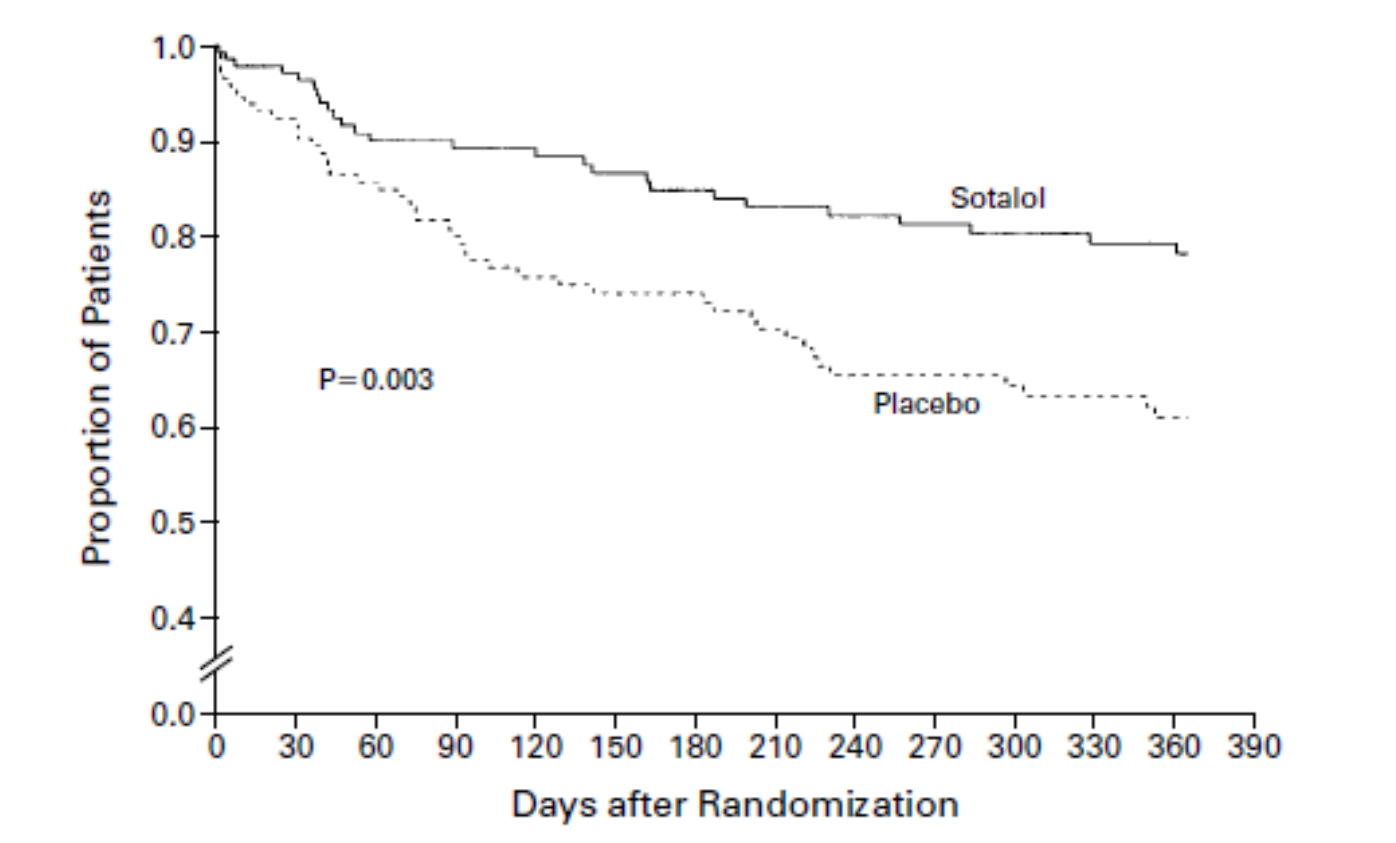
Randomized, Double-Blind Comparison of Intravenous Amiodarone and Bretylium in the Treatment of Patients With Recurrent, Hemodynamically Destabilizing VentricularTachycardia or Fibrillation [Intravenous Amiodarone Multicenter Investigators Group]



Kowey P, *Circulation.* 1995;92:3255-3263

PREVENTION OF IMPLANTABLE-DEFIBRILLATOR SHOCKS BY TREATMENT WITH SOTALOL

ANTONIO PACIFICO, M.D., STEFAN H. HOHNLOSER, M.D., JOHN H. WILLIAMS, M.D., BEN TAO, M.SC., SANJEEV SAKSENA, M.D., PHILIP D. HENRY, M.D., AND ERIC N. PRYSTOWSKY, M.D., FOR THE *d,l*-SOTALOL IMPLANTABLE CARDIOVERTER–DEFIBRILLATOR STUDY GROUP*



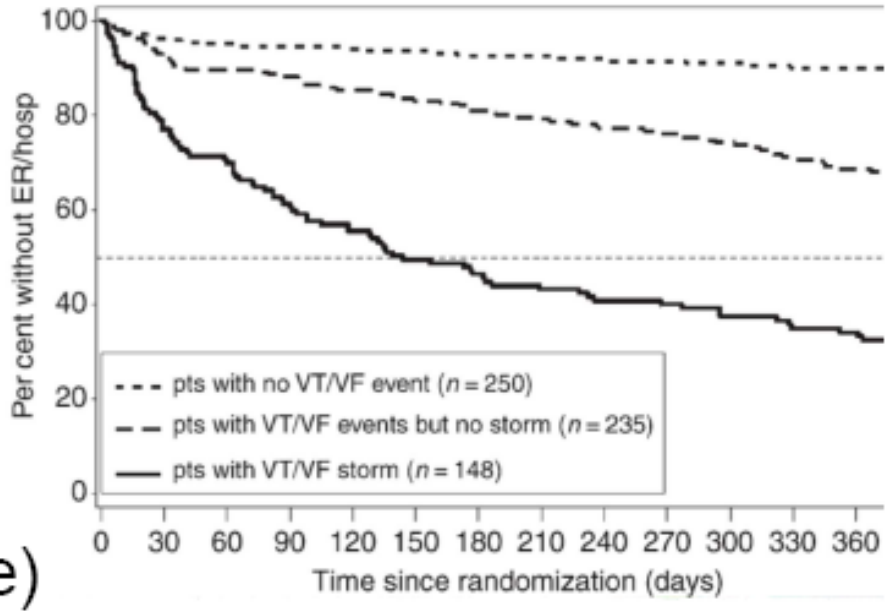
. Time to Death or the Delivery of an Appropriate First Shock for Ventricular Tachyarrhythmia

(N Engl J Med 1999;340:1855-62.)

Drug Therapy: Azimilide

SHIELD RCT (2° analysis)

- n = 633
  - ES over 1 yr in 23%
  - no clinical predictors
  - most cases of ES 2° to frequent VT (91%)



Time to ES (1° outcome)

- RR 0.69 (95% CI 0.5, 1.0); p = 0.07

Recurrent risk of ES (2° outcome)

- RR 0.45 (95% CI 0.2, 0.9); p < 0.02

Hohnloser et al. EHJ **2006**;27:3027–32

Αναστρέψιμα Αίτια

- Διαταραχές ηλεκτρολυτών (K – Mg)
- Ισχαιμία → PCI- CABG
- Καρδιακή ανεπάρκεια (φαρμακευτική αγωγή – αποφυγή ανεπιθύμητης καρδιακής βηματοδότησης- MVP αλγόριθμοι, CRT-D)

Resynchronization Therapy

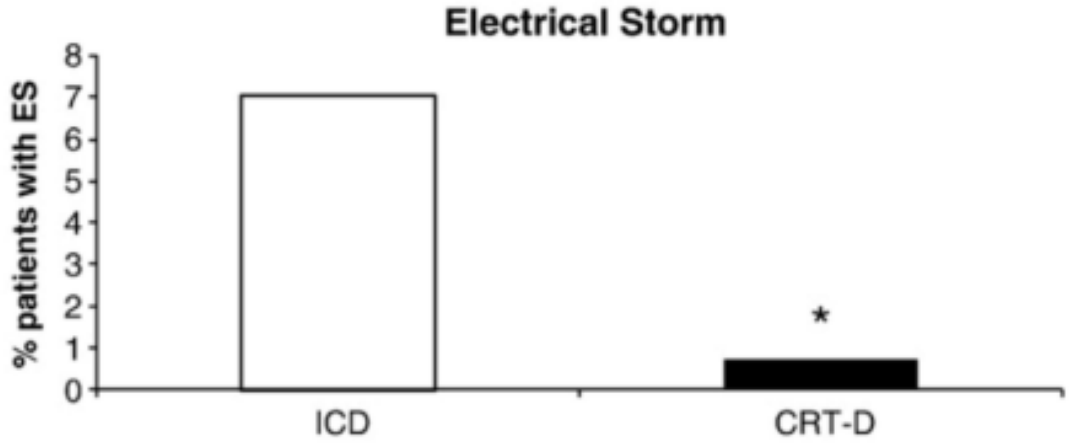
N = 168 CRT-D

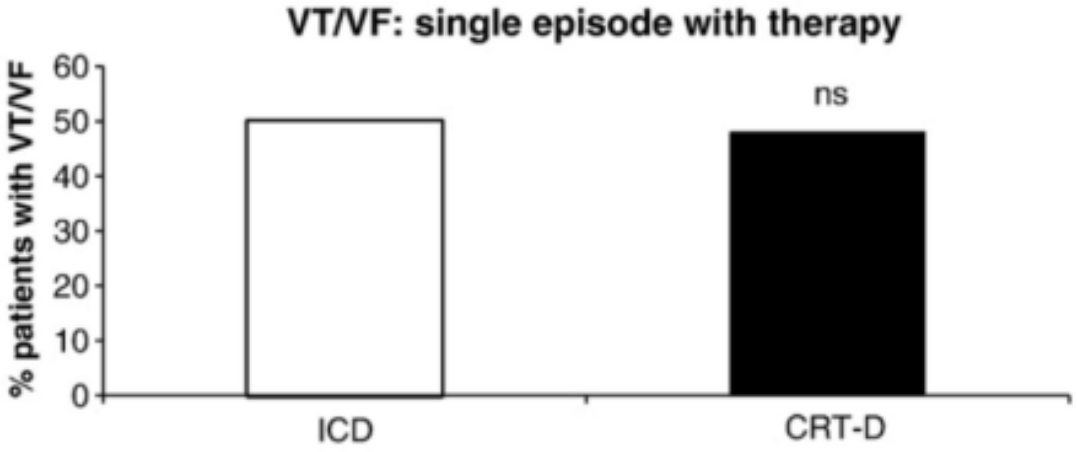
N = 561 ICD

Observational

Mean follow-up

41 mo.





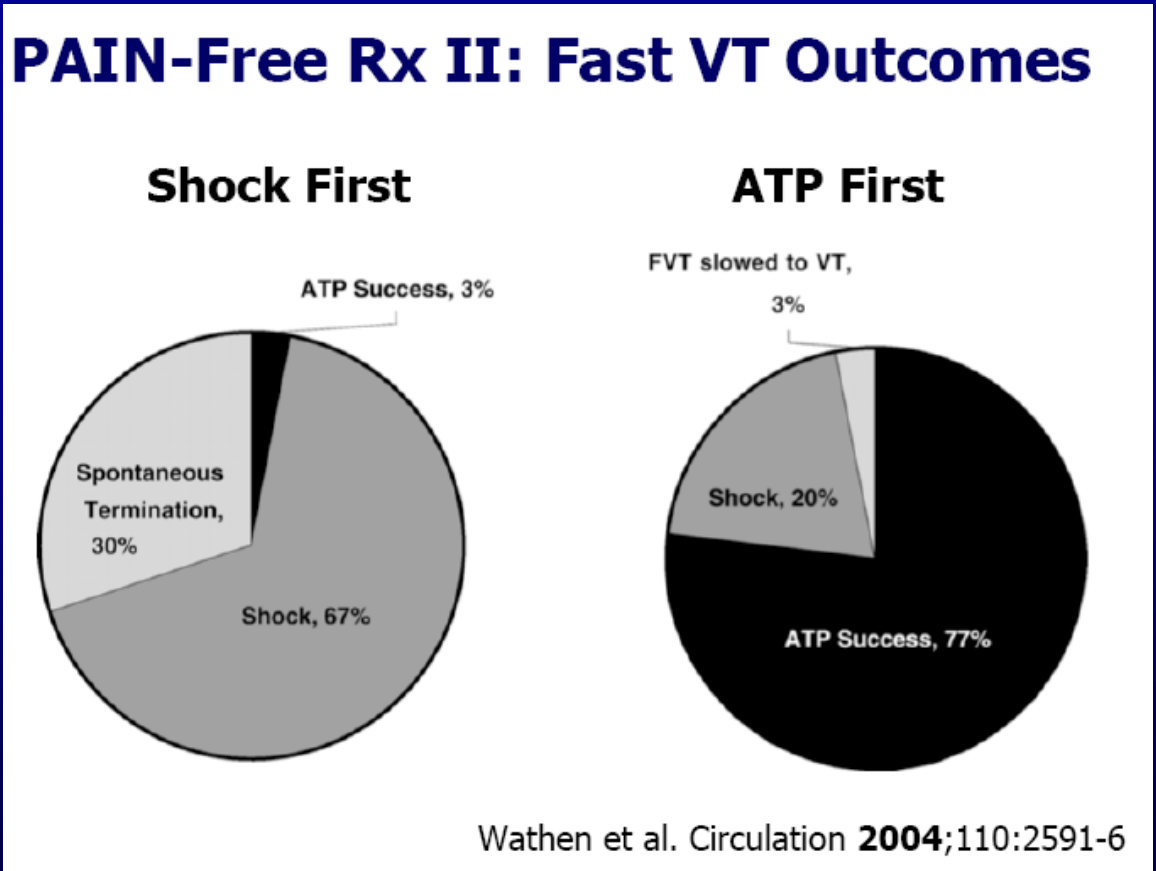
Nordbeck et al. Int J Cardiol (**2009**) doi:10.1016/j.ijcard.2009.03.055

Ορθός προγραμματισμός ICD

- Ελαχιστοποίηση πιθανότητας shock για VT → ATP-- DEFINITE: many VT episodes **do not need** to be treated (NS-VT)
- VT cycles necessary for detection (usually 20 cycles for VT) → to 30-40
- Shock after a programmable time window (usually 30 sec)→ extend to 2-5 min, άσχετα από προγραμματισμό ATP

Ορθός προγραμματισμός ICD

Ελαχιστοποίηση πιθανότητας χορήγησης shock -ATP



PREPARE: Shock Reduction

Cohort (DR / CRT)

n = 658

extended detects

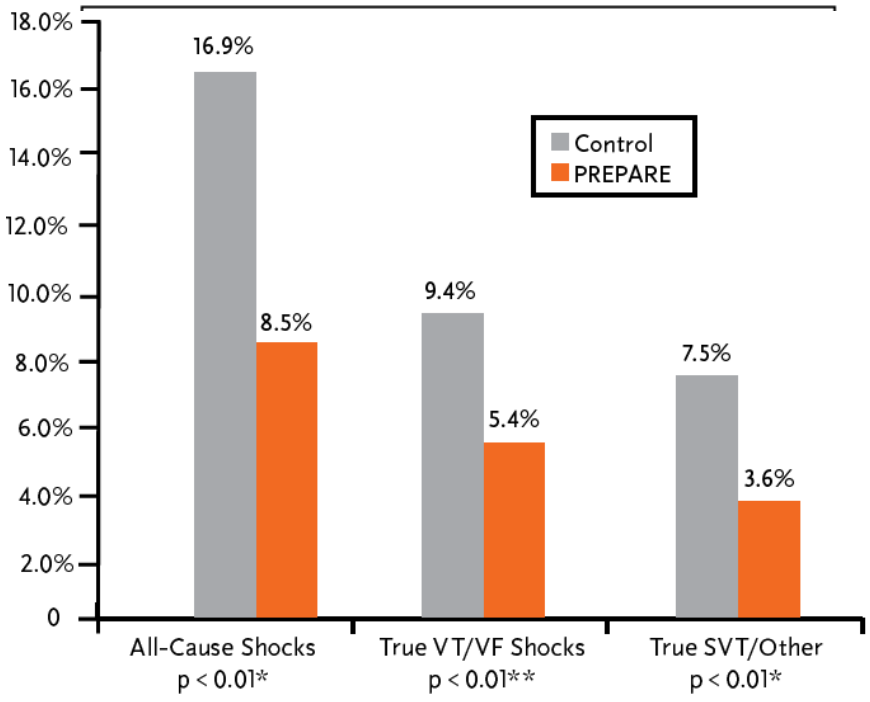
> 182 bpm (< 330 ms)

30 of 40 intervals

n = 689 controls

Fewer shocks with extended detects ($p < 0.0001$)

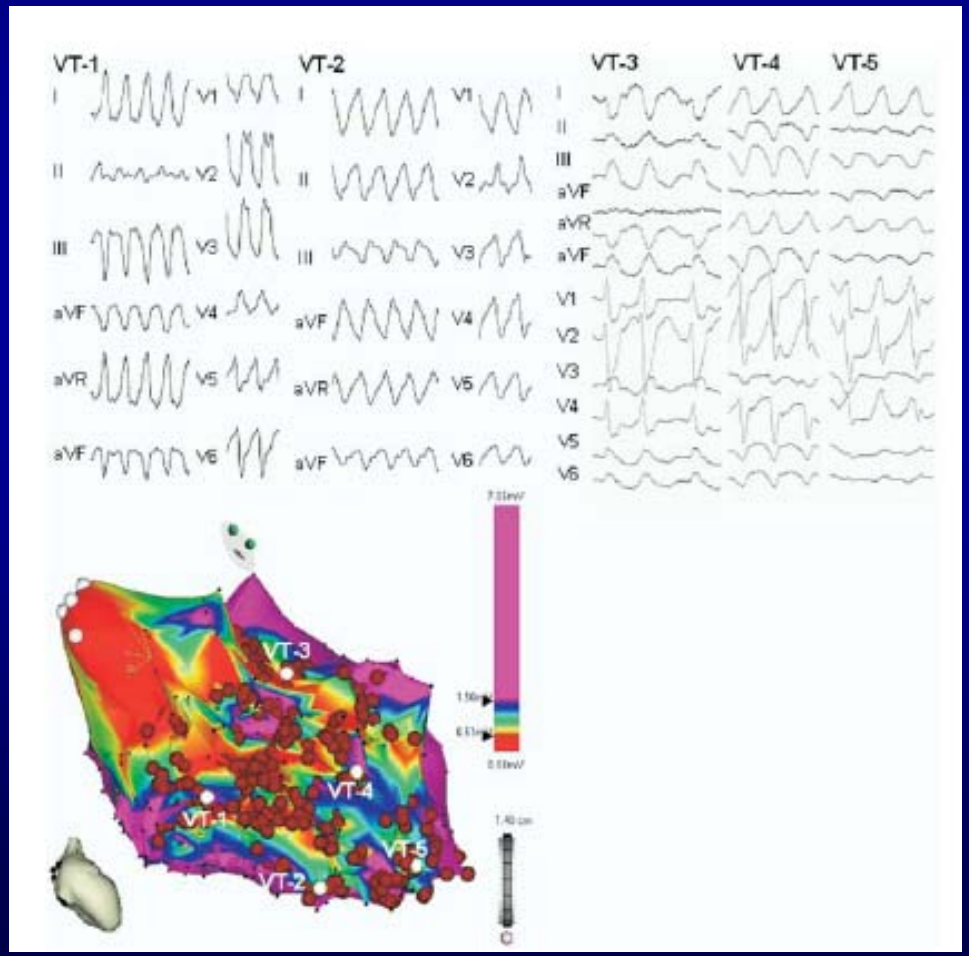
0.8% arrhythmic syncope risk

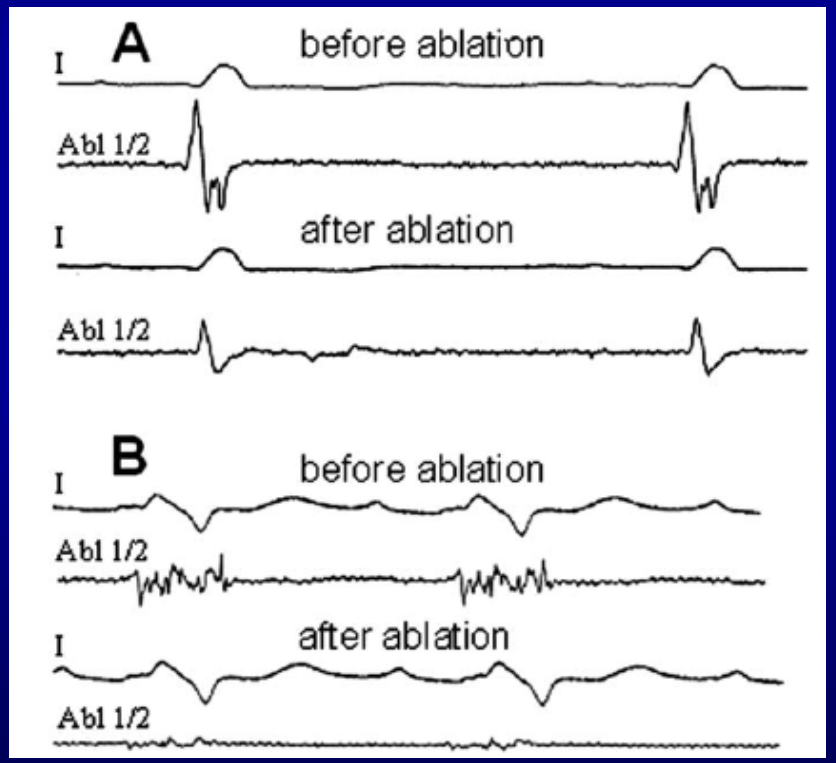


Wilkoff et al. J Am Coll Cardiol **2008**;52:541-50.

Rescue ablation of electrical storm in patients with ischemic cardiomyopathy: A potential-guided ablation approach by modifying substrate of intractable, unmappable ventricular tachycardias

Juergen Schreieck, MD,[a] Bernhard Zrenner, MD,[b] Isabel Deisenhofer, MD,[b] Claus Schmitt, MD[b]





(Heart Rhythm 2005;2:10–14)

Catheter Ablation for the Treatment of Electrical Storm in Patients With Implantable Cardioverter-Defibrillators: Short- and Long-Term Outcomes in a Prospective Single-Center Study

Corrado Carbucicchio, Matteo Santamaria, Nicola Trevisi, Giuseppe Maccabelli, Francesco Giraldi, Gaetano Fassini, Stefania Riva, Massimo Moltrasio, Manuela Cireddu, Fabrizio Veglia and Paolo Della Bella

Circulation 2008;117:462-469; originally published online Jan 2, 2008;

N = 95

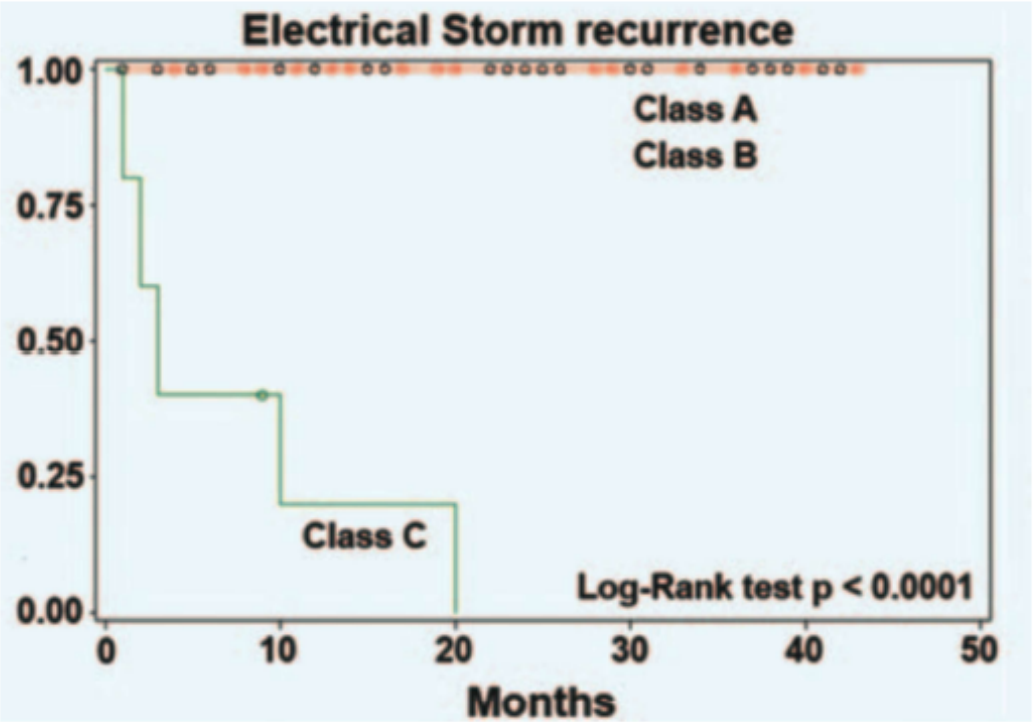
- CAD 72 (%)
- DCM 10 (%)
- ARVC 13 (%)

EF 0.36 (0.11)

Mostly NYHA II-III

Amiodarone (94%)

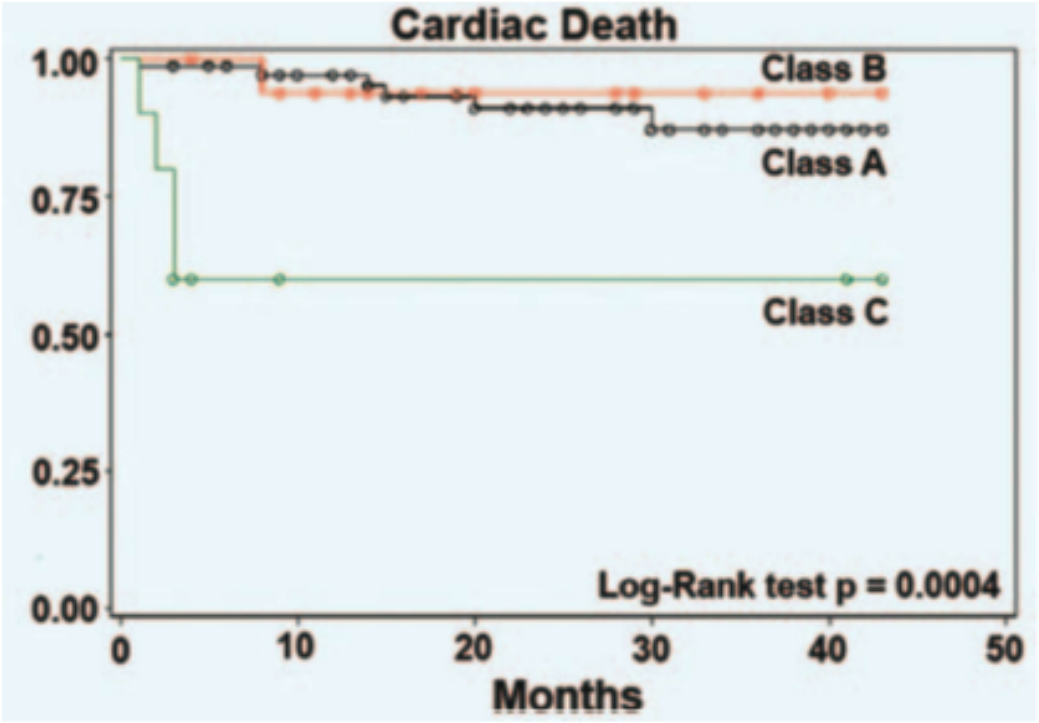
Beta-blockers (97%)



Success: Complete (72%), Partial (18%), Failure (10%)

Ablation Therapy for Electrical Storm

No difference in overall survival, but a reduced risk of CV death with partial or complete ablation success.



follow-up of 22 months (range, 1 to 43 months), 87 patients (92%) were free of ES

Συμπεράσματα

- 25% σε 3 τριετία (6-36 μήνες από εμφύτευση)
- 1% άμεση θνητότητα, αλλά 50-80% νοσηλεία - δυσμενής πρόγνωση
- Αναστρέψιμα αίτια, β-αποκλειστές, αμιωδαρόνη, προγραμματισμός ICD, προφυλακτική αντιαρρυθμική αγωγή