PLACE

PLATFORM OF LABORATORIES FOR ADVANCES IN CARDIAC EXPERIENCE

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PRIMUM NON NOCERE: MENO SHOCK INAPPROPRIATI, PIÙ QUALITÀ DI VITA PER I PAZIENTI ICD/CRT

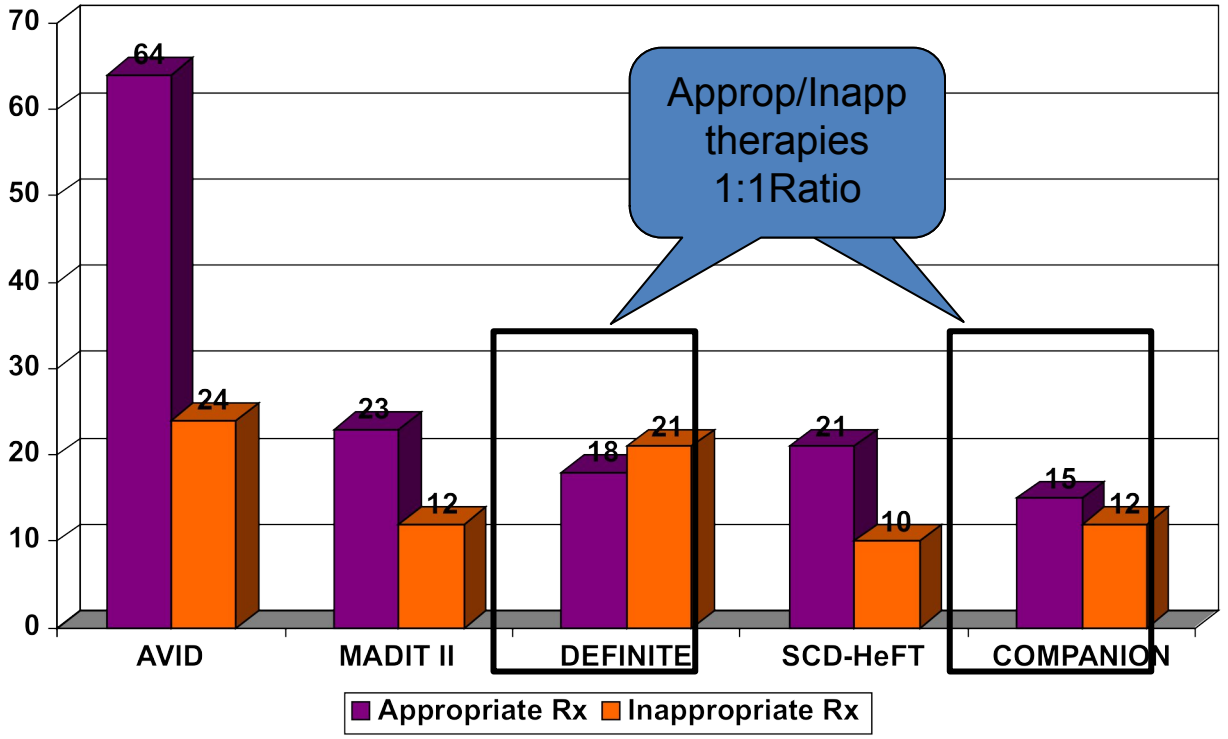
Pasquale Notarstefano

Dipartimento CardioToracoNeuroVascolare
USL SUDEST Toscana
UOC Cardiologia
P.O. S.Donato, Arezzo

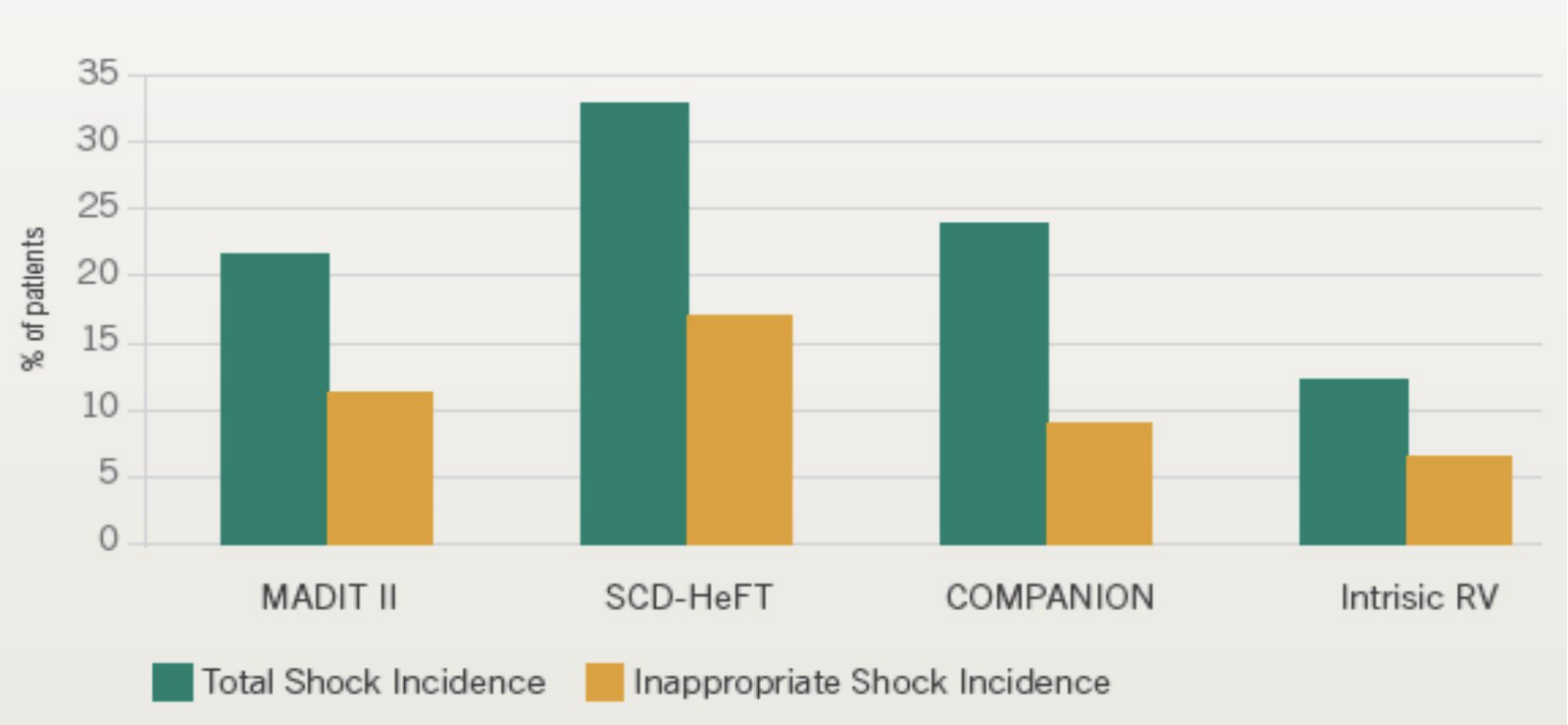
Conflitto di interessi

- Nessuno pertinente a questa presentazione

Inappropriate shocks: a relevant issue



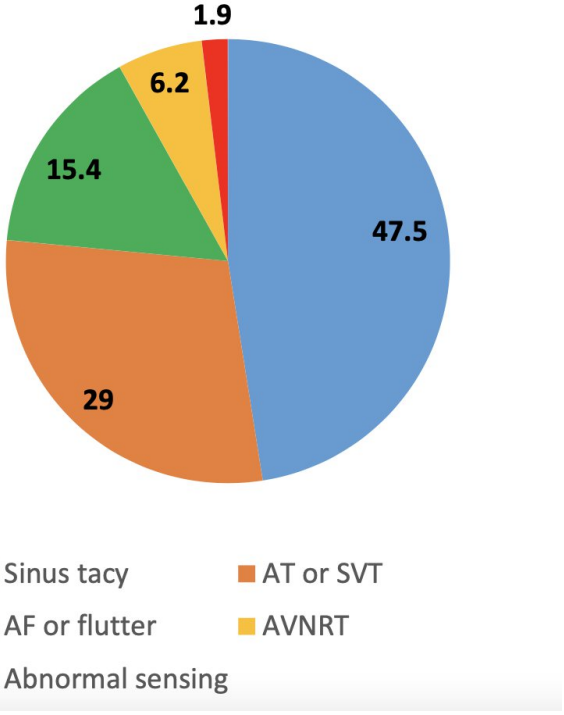
Inappropriate shocks: a relevant issue



Main causes of Inappropriate Shocks

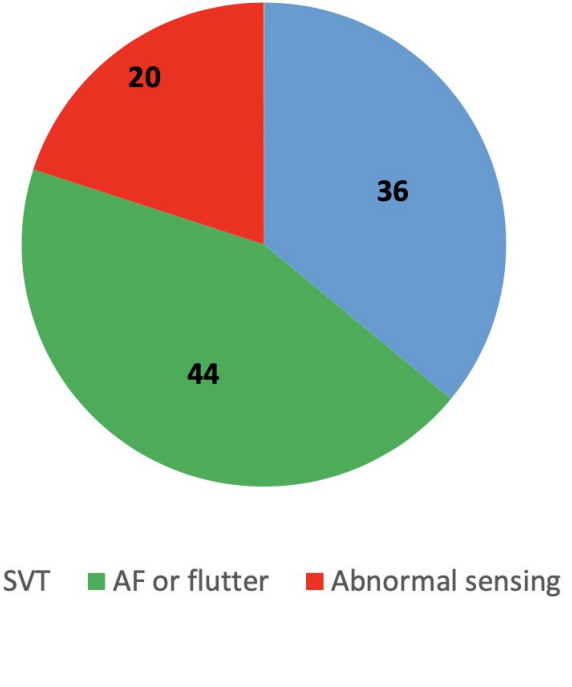
SCD-HeFT

Poole JE. *N Eng J Med* 2008; 359:1009-17.



MADIT II

Daubert JB. *J Am Coll Cardiol* 2008; 51:1357-65.



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Main causes of Inappropriate Shocks

	Total (n = 1,544)	Single-Chamber ICD (n = 188)	Dual-Chamber ICD (n = 819)	CRT-D (n = 537)
Patients with ≥1 inappropriate shock	204 (13)	29 (15)	122 (15)	53 (10)
Rhythm misdiagnosis				
Supraventricular tachycardia	155 (76)	19 (65)	96 (79)	40 (75)
AF	92 (45)	14 (48)	55 (45)	23 (43)
Other than AF	63 (31)	5 (17)	41 (34)	17 (32)
Abnormal sensing	25 (12)	2 (8)	15 (12)	8 (15)
Sinus tachycardia	22 (11)	7 (24)	10 (8)	5 (10)
Unclassified	2 (1)	1 (3)	1 (1)	0 (0)

76%

of IS are the result of device misclassification

Van Rees JB, JACC 2011; 57:556-62

Prognostic impact in MADIT II and SCD-HeFT

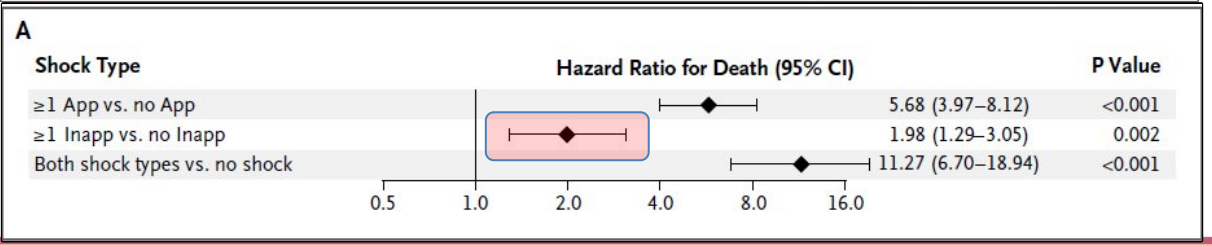
Table 6 Predictors of All-Cause Mortality by Cox Proportional Hazards Regression Analysis

Variable	Hazard Ratio	95% Confidence Interval	p Value
Baseline characteristics			
Blood urea nitrogen >25	2.07	1.38–3.11	<0.01
No beta-blocker	1.64	1.09–2.47	0.02
Interim events			
Interim CHF hospitalization	4.23	2.70–6.62	<0.01
Appropriate and inappropriate shock	4.08	1.71–9.75	<0.01
Appropriate shock only	3.36	2.04–5.55	<0.01
Inappropriate shock only	2.29	1.11–4.71	0.02
Appropriate and inappropriate therapy	3.12	1.38–7.03	<0.01
Appropriate therapy only	2.53	1.54–4.15	<0.01
Inappropriate therapy only	2.01	0.97–4.13	0.06
Appropriate ATP but not shock	0.412	0.148–1.150	0.0903
Inappropriate ATP but not shock	0.729	0.213–2.496	0.6145

Daubert PJ, J Am Coll Cardiol 2008;51:1357–65)

Inappropriate shocks were associated with a near doubling of the risk of death.

Figure 1. Hazard Ratios for the Association of ICD Shock with the Risk of Death, According to Shock Type.



Poole JE, N Engl J Med. 2008;359(10):1009-1017

IS shocks decrease QoL

SF-36 domains	Atrial fibrillation		Heart failure		Appropriate therapy		Inappropriate shock	
	p-value	ES	*p*-value	ES	*p*-value	ES	*p*-value	ES
Physical functioning	**<0.001**	0.47	**<0.001**	0.68	0.812		0.119	
Role physical	**0.002**	0.38	**0.003**	0.48	0.211		0.382	
Bodily pain	**0.051**	0.26	0.260		0.229		0.188	
General health	**0.004**	0.38	**0.023**	0.33	0.864		0.118	
Vitality	0.234		**0.075**	0.30	0.166		**0.080**	0.31
Social functioning	**0.004**	0.42	**0.069**	0.36	0.180		**0.058**	0.37
Role emotional	0.234		0.195		0.209		**0.028**	0.42
Mental health	0.288		0.681		**0.033**	0.30[a]	0.242	
Physical Component Summary	**<0.001**	0.48	**<0.001**	0.63	0.735		0.252	
Mental Component Summary	0.495		0.884		**0.076**	0.27[a]	**0.060**	0.38

HCM patients with ICDs suffer from poor HRQL regardless of age, sex, or primary vs secondary prevention indication. Atrial fibrillation and systolic heart failure are determinants of poor physical health. **Inappropriate shocks**, but not appropriate therapies, **are associated with poorer mental health.**

Magnusson et al. Health and Quality of Life Outcomes (2016) 14:62

Healthcare Utilization and Expenditures Associated With Appropriate and Inappropriate Implantable Defibrillator Shocks

Table 4. Outpatient Shock-Related Procedures

Procedure	All Outpatient Visits (n=608)*	Appropriate (n=346)	Inappropriate (n=233)
Device interrogation	599 (76.1%)	362 (80.8%)	231 (78.3%)
ECG	578 (73.4%)	316 (70.5%)	220 (74.6%)
Ambulance transportation	483 (61.4%)	254 (56.7%)	185 (62.7%)
Emergency room visit	359 (45.6%)	183 (40.8%)	152 (51.5%)
Chest x-ray	320 (40.7%)	175 (39.1%)	124 (42.0%)

WHAT THE STUDY ADDS

- In patients with ICDs, 46% of shock events had shock-related HCU.
- After shocks, inpatient cardiovascular procedures were common, and expenditures were not significantly different following inappropriate versus appropriate shocks.
- ICD shocks seem to trigger a cascade of health care, and strategies to reduce shocks could result in cost savings.

Table 2. Inpatient Shock-Related Procedures

	All Inpatient Visits (n=259)*	Appropriate (n=155)	Inappropriate (n=80)
Any procedure (primary or secondary)			
ECG	221 (85.3%)	144 (92.9%)	58 (72.5%)
Chest x-ray	196 (75.7%)	124 (80.0%)	54 (67.5%)
Cardiac catheterization	196 (75.7%)	123 (79.4%)	41 (51.3%)
Echocardiography	152 (58.7%)	94 (60.6%)	41 (51.3%)
Emergency room visit	103 (39.8%)	67 (43.2%)	28 (35.0%)
Electrophysiology study/ ablation	87 (33.6%)	61 (39.4%)	9 (11.3%)
Device interrogation	67 (25.9%)	47 (30.3%)	15 (18.8%)
Stress test	42 (16.2%)	29 (18.7%)	7 (8.8%)
Lead or device revision	28 (10.8%)	8 (5.2%)	23 (28.8%)
Percutaneous coronary intervention	17 (6.6%)	10 (6.5%)	4 (5.0%)
Circulatory support	9 (3.1%)	7 (4.5%)	0 (0.0%)
Heart/pericardium operations	5 (1.9%)	3 (1.9%)	2 (2.5%)
Cardioversion	4 (1.5%)	1 (0.6%)	2 (2.5%)

Turakhia MP Circ Cardiovasc Qual Outcomes. 2017;10:e002210.

Strategies to reduce inappropriate shocks

Effects of prolonged Tachycardia detection on IS

Study	Participants (*N*)	Short detection controls	Prolonged detection intervention	Findings
PREPARE	1391 Nonrandomized primary prevention	12 of 16 (58%) 18 of 24 (42%)	30 of 40	Reduction in inappropriate shocks (SVT), avoidable shocks (VT), and 'morbidity index'
RELEVANT	324 Nonrandomized primary prevention	12 of 16	30 of 40	Reduction in inappropriate shocks (SVT), avoidable shocks (VT), and HF hospitalizations
MADIT-RIT	1500 Randomized primary prevention	2.5 s (170–199 bpm) 1 s (≥200 bpm)	60 s (170–199 bpm) 12 s (200–249 bpm) 2.5 s (≥250 bpm)	Reduction in first inappropriate therapy, first appropriate therapy, appropriate ATP, and inappropriate ATP; improved survival
ADVANCE III	1902 Randomized primary and secondary prevention	18 of 24	30 of 40	Reduction in overall therapies, inappropriate shocks, and all-cause hospitalizations
PROVIDE	1670 Randomized primary prevention	12 beats	25 beats (180–214 bpm) 18 beats (214–250 bpm) 12 beats (>250 bpm)	Reduction in all-cause shock rate; improved survival

MADIT-RIT

Conventional therapy (N=514)	High Rate Therapy (N=500)	Delayed Therapy (N=486)
Zone 1: ≥170 bpm, 2.5 s delay	Zone 1: ≥170 bpm: **monitor only**	Zone 1: ≥170 bpm, **60s delay**
Zone 2: ≥200 bpm, 1s delay	Zone 2: ≥200 bpm, 2.5 s delay	Zone 2: ≥200 bpm, **12s delay**
		Zone 3: >250 bpm, **2.5s delay**

Hypothesis: programming devices to deliver therapy at ≥ 200 bpm or to increase the duration of the monitoring delay before the initiation of therapy would decrease the number of patients receiving inappropriate therapies without increasing morbidity or mortality, as compared with conventional programming.

Moss A , NEJM 2012; 367:2275-83

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MADIT-RIT

Results

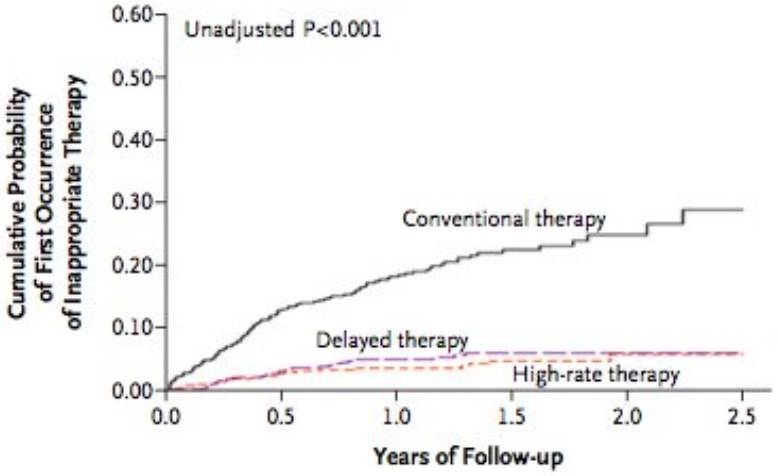

Table 3. Hazard Ratios for a First Occurrence of Inappropriate Therapy, Death, and a First Episode of Syncope According to Treatment Group.

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

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MADIT-RIT

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	196	<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

Supraventricular Tachycardia discriminators

- Onset
- Stability
- Morphology

Manufacturer	Algorithm
BIOTRONIC	Pr logic
BOSTON	Rhythm ID
MEDTRONIC	SST
ABBOTT	Smart
MICROPORT	Parad +

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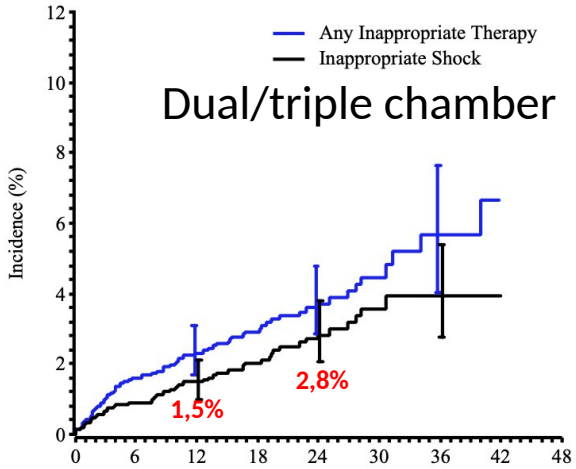
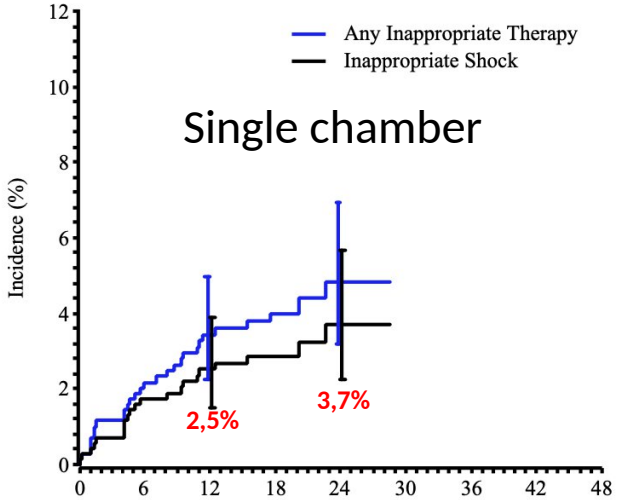
PainFree SST

Purpose

To investigate new-generation ICDs to reduce inappropriate and unnecessary shocks through novel discrimination algorithms with modern programming strategies.





The adoption of novel enhanced detection algorithms in conjunction with routine implementation of modern programming strategies led to a low inappropriate shock rate.

Auricchio A, Heart Rhythm 2015;12:926–936

ISIS Study

Purpose

assess IS reduction with the PARAD+ discrimination algorithm in a wide spectrum of frequencies without the programming of a high cut-off rate and/or extended persistence

DR-ICD or CRT-ICD

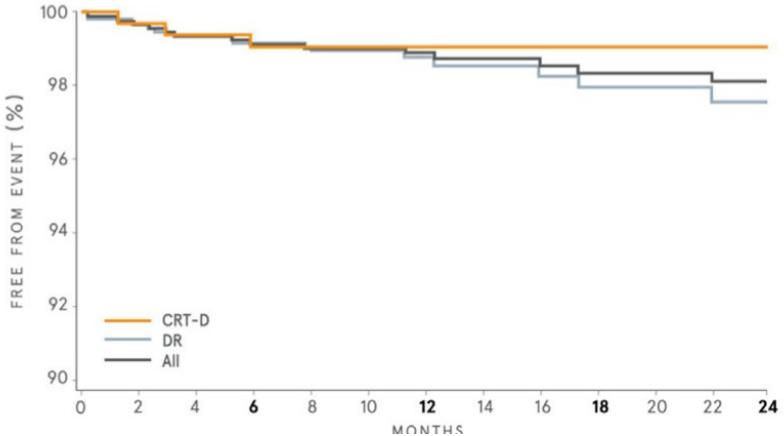
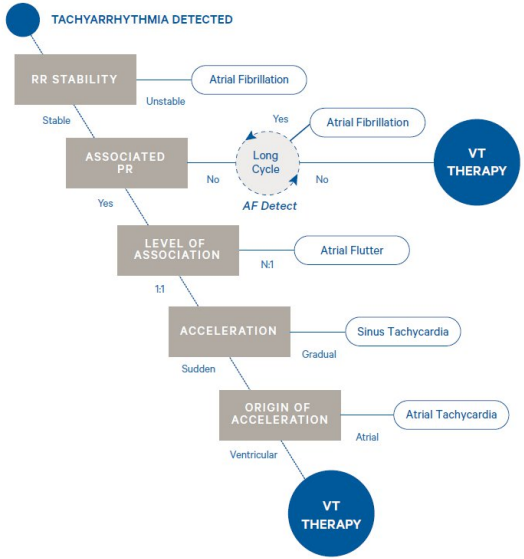


Table 1 Mandatory programming of devices

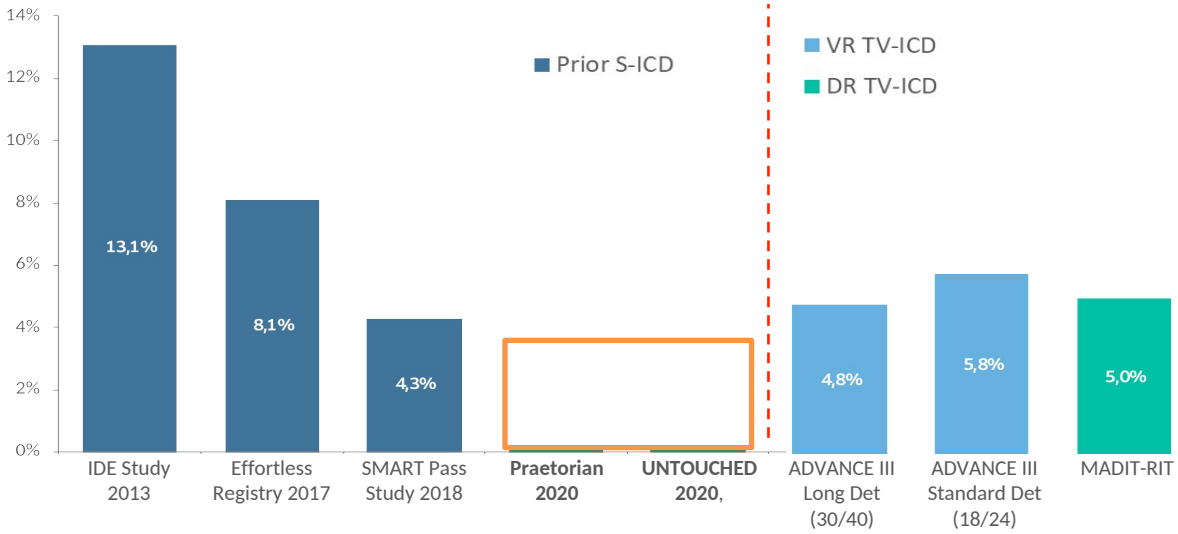
	Slow VT ON	VT ON	Fast VT+VF (
Rate ranges	**150**	**185**	**230**
Persistence ranges	**30**	**16**	**8**
Detection criteria	PARAD+		Rate + stabi
Therapies	**ATP1**	**ATP1**	**ATP**
	ATP2	**Shocks**	**Shocks**
	Shocks		



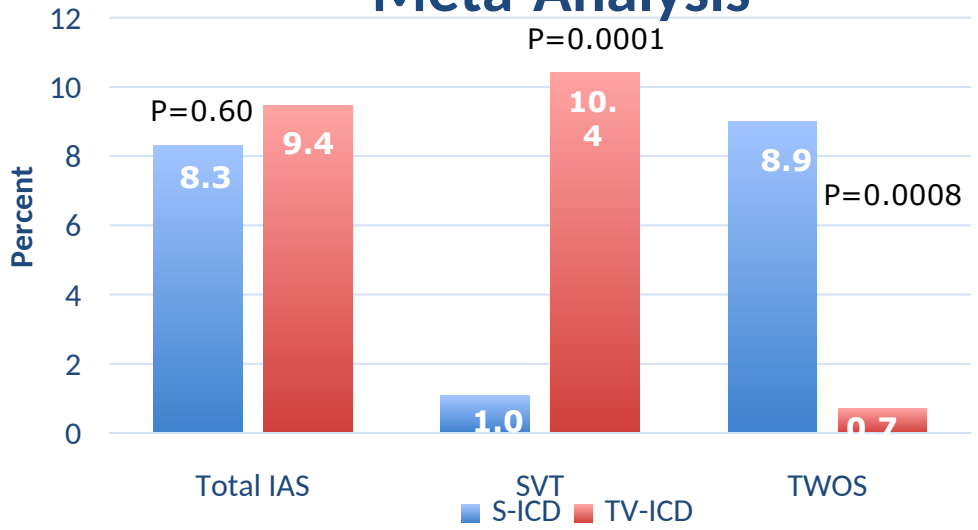
The annual patient incidence rate of IS ranged from 1.0 (primary analysis) to 2.1 (worst-case analysis) per 100 person-years.

Ruiz-Granell R, Heart Rhythm 2019;16:1429–1435

Inappropriate shocks in S-ICD



S-ICD vs TV ICD Meta-Analysis



- Overall rate of inappropriate shocks did not differ between S-ICD and TV-ICD.
- The rate of IAS due to SVT was **significantly higher** in TV-ICD than S-ICD.
- The rate of IAS due to T-wave oversensing (TWOS) was significantly higher in S-ICD* than TV-ICD.

Basu-Ray I, JACC EP 2017

PRAETORIAN Study

Class I & IIa indication no need for pacing

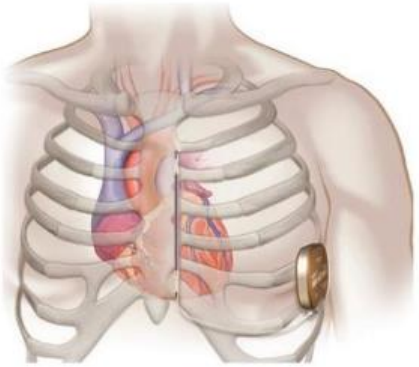
n=849

S-ICD

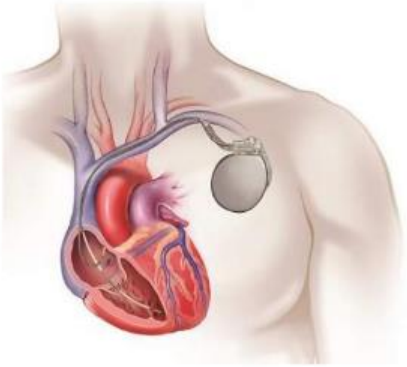
TV-ICD

Median follow up 48 months

Primary Endpoint: Non-Inferiority
Complications + Inappropriate shocks



vs



Prospective Randomized

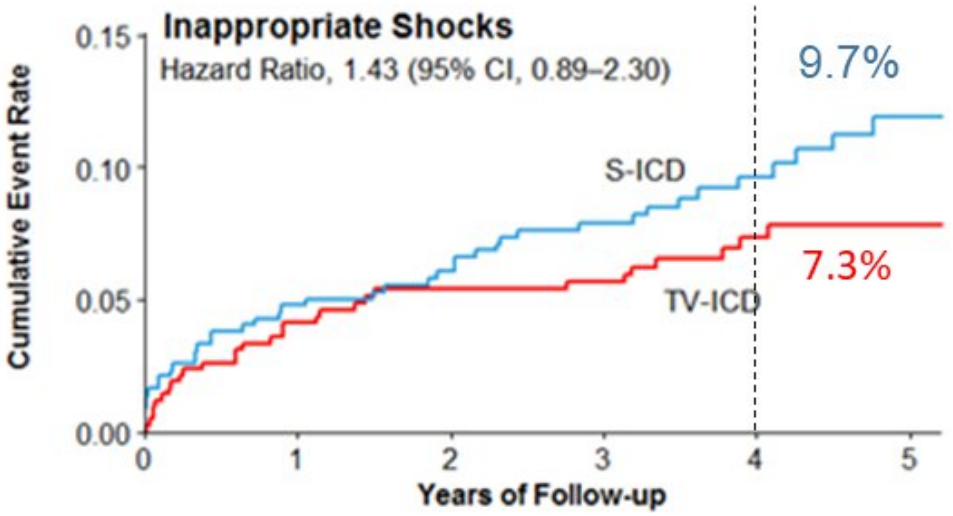
KNOPS, NEJM 2020; 383:526-536

PRAETORIAN Study

No significant difference in rate of IAS, which were low for both the S-ICD & TV-ICD groups

- ✓ 4.1% at 1 year in the TV-ICD arm vs
- ✓ 4.8% in the S-ICD arm

- Key Points
- *The IAS rate is nearly identical for the first 2 years which includes data from the **EMBLEM S-ICD devices**. The early implant with **Gen 2011 S-ICD** are likely driving the curves to separate after 2 years.*



KNOPS, NEJM 2020; 383:526-536

PRAETORIAN Study

- Key Points
- *The rate of IAS due to Afib was higher in TV-ICD than S-ICD.*
- *The rate of IAS due to oversensing was higher in S-ICD than TV-ICD.*
  - ✓ *The **SMART Pass™ sensing filter**, which has been shown to reduce IAS by 68%, was enabled in only 11% of S-ICD patients at the time of inappropriate shock.*

Causes of Inappropriate Shocks

At 4 years (median)	S-ICD (n = 426)	TV-ICD (n = 423)
Primary composite endpoint	68 (15.1%)	68 (15.7%)
Inappropriate shock	41 (9.7%)	29 (7.3%)
– AF/SVT	15	27
– Cardiac oversensing	20	2
– Noncardiac oversensing	8	0

KNOPS, NEJM 2020; 383:526-536

UNTOUCHED Study

Hypothesis: The incidence of IAS for S-ICD in primary prevention, LVEF ≤ 35% patients will be non-inferior to the rate in TV-ICD patients with similar programming observed in MADIT-RIT high rate and long duration arms.

Design	Objective	Endpoint	#pts
Post-approval, global, non-mandated, single arm, multicentre, prospective.	Compare, in primary prevention patients with EF ≤ 35%, the incidence of inappropriate shocks (during 18 months) with the EMBLEM S-ICD. **Devices are programmed with zone cut-offs at 200 and 250**, and compared to objective performance criteria derived from contemporary data on transvenous ICDs programmed to minimize shocks.	**Primary effectiveness endpoint** is **freedom from inappropriate shocks at 18 months** compared to a performance goal of 91.6%.	1,111

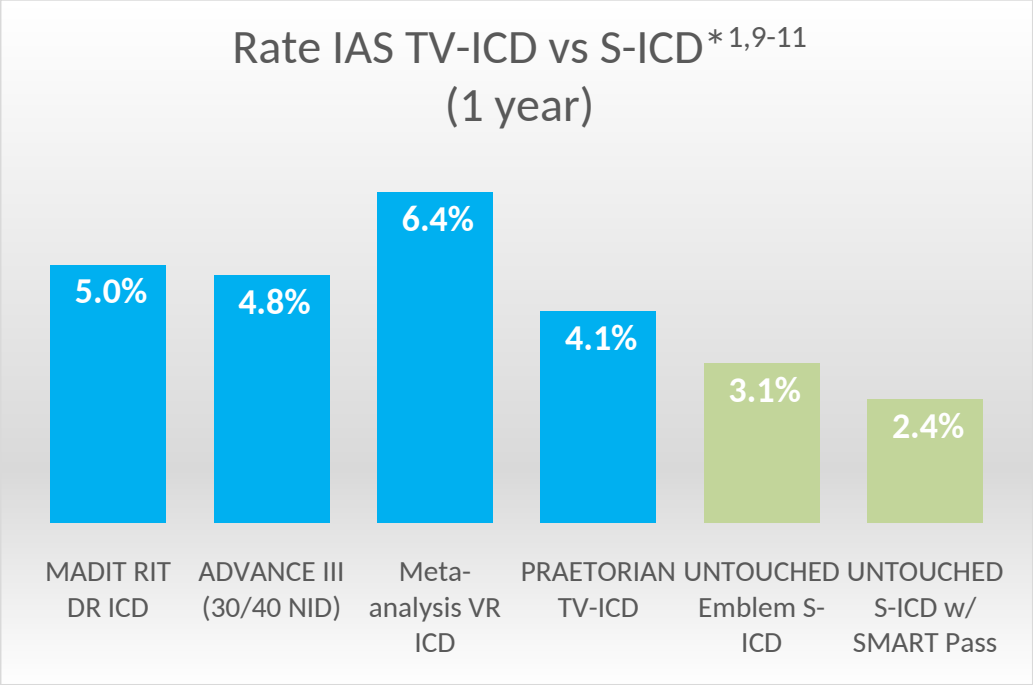
GOLD MR, Circulation 2021;143:7–17

UNTOUCHED Study

Inappropriate shocks (IAS)

Low rate of IAS in Primary Prevention low EF
- ✓ 3.1% overall rate of IAS at 1 year[12]
- ✓ 2.4% at 1 year in patients who received an EMBLEM MRI w/ SMART Pass™ Filter [12]

- Key points
- *The IAS rate of S-ICD's was comparable to the rate of IAS observed in other contemporary studies with TV-ICDs including the PRAETORIAN trial*



KNOPS, NEJM 2020; 383:526-536

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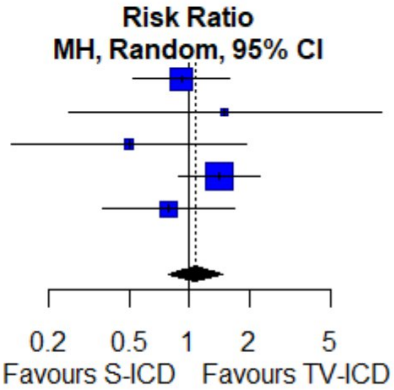
Subcutaneous vs Transvenous ICD

A Systematic Review and Meta-Analysis of Randomized Trials and Propensity Score–Matched Studies

Study	S-ICD Events	S-ICD Total	TV-ICD Events	TV-ICD Total	Weight	Risk Ratio MH, Random, 95% CI
Brouwer 2016	20	140	22	140	30.2%	0.91 [0.52; 1.59]
Brouwer 2018	3	391	2	391	3.0%	1.50 [0.25; 8.93]
Honarbakhsh 2017	3	69	6	69	5.2%	0.50 [0.13; 1.92]
Knops 2020	41	426	29	423	45.3%	1.40 [0.89; 2.22]
Palmisano 2021	11	169	14	169	16.3%	0.79 [0.37; 1.68]
Random effects model		**1195**		**1192**	**100.0%**	**1.06 [0.78; 1.45]**

Heterogeneity: $Tau^2 = 0$; $Chi^2 = 3.69$, df = 4 (P = 0.45); $I^2 = 0\%$



Forest plots for inappropriate shocks

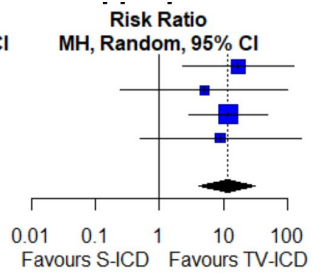
Fong KY *J Am Heart Assoc.* 2022;11:e024756.

Subcutaneous vs Transvenous ICD

Cardiac oversensing
as a cause of inappropriate shocks

Study	S-ICD Events	S-ICD Total	TV-ICD Events	TV-ICD Total	Weight	Risk Ratio MH, Random, 95% CI
Brouwer 2016	17	140	1	140	25.9%	17.00 [2.29; 126.01]
Brouwer 2018	2	391	0	391	11.3%	5.00 [0.24; 103.81]
Knops 2020	24	426	2	423	50.5%	11.92 [2.83; 50.10]
Palmisano 2021	4	169	0	169	12.3%	9.00 [0.49; 165.87]
Random effects model		**1126**		**1123**	**100.0%**	**11.44 [4.12; 31.74]**

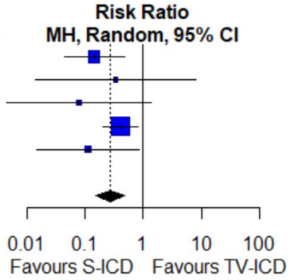
Heterogeneity: $Tau^2 = 0$; $Chi^2 = 0.47$, df = 3 (P = 0.92); $I^2 = 0\%$



SVT or AF
as a cause of inappropriate shocks

Study	S-ICD Events	S-ICD Total	TV-ICD Events	TV-ICD Total	Weight	Risk Ratio MH, Random, 95% CI
Brouwer 2016	3	140	21	140	22.3%	0.14 [0.04; 0.47]
Brouwer 2018	0	391	1	391	3.1%	0.33 [0.01; 8.16]
Honarbakhsh 2017	0	69	6	69	3.9%	0.08 [0.00; 1.34]
Knops 2020	11	426	27	423	63.0%	0.40 [0.20; 0.80]
Palmisano 2021	1	169	9	169	7.6%	0.11 [0.01; 0.87]
Random effects model		**1195**		**1192**	**100.0%**	**0.27 [0.15; 0.48]**

Heterogeneity: $Tau^2 = 0.0102$; $Chi^2 = 4.07$, df = 4 (P = 0.40); $I^2 = 2\%$



Fong KY *J Am Heart Assoc.* 2022;11:e024756.

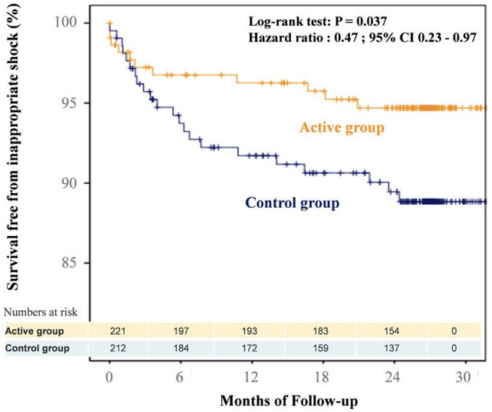
PLACE 9ª Edizione

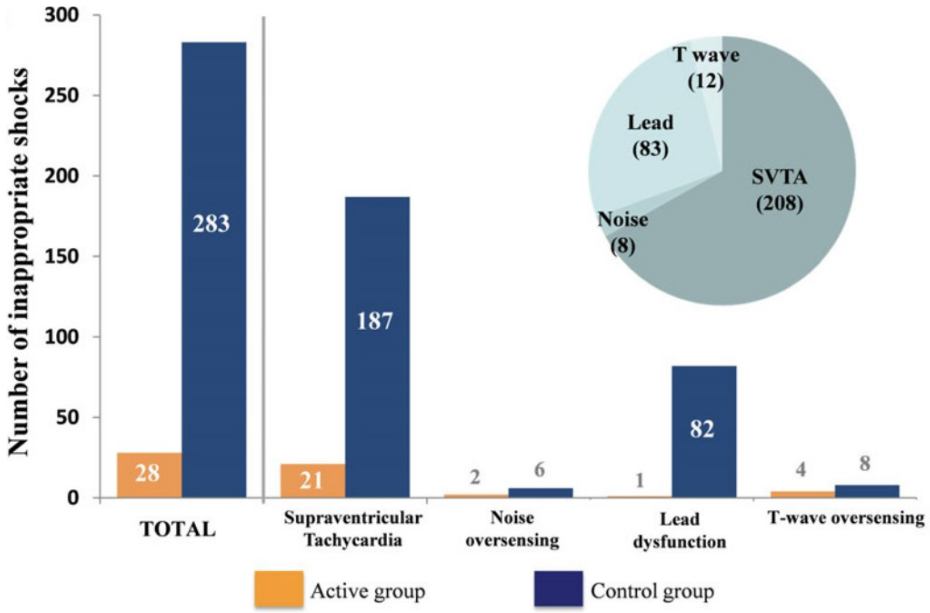
Inappropriate Shocks Reduction by Remote ICD Monitoring

ECOST Trial

Appropriate and Inappropriate Shocks Delivered in Each Study Group

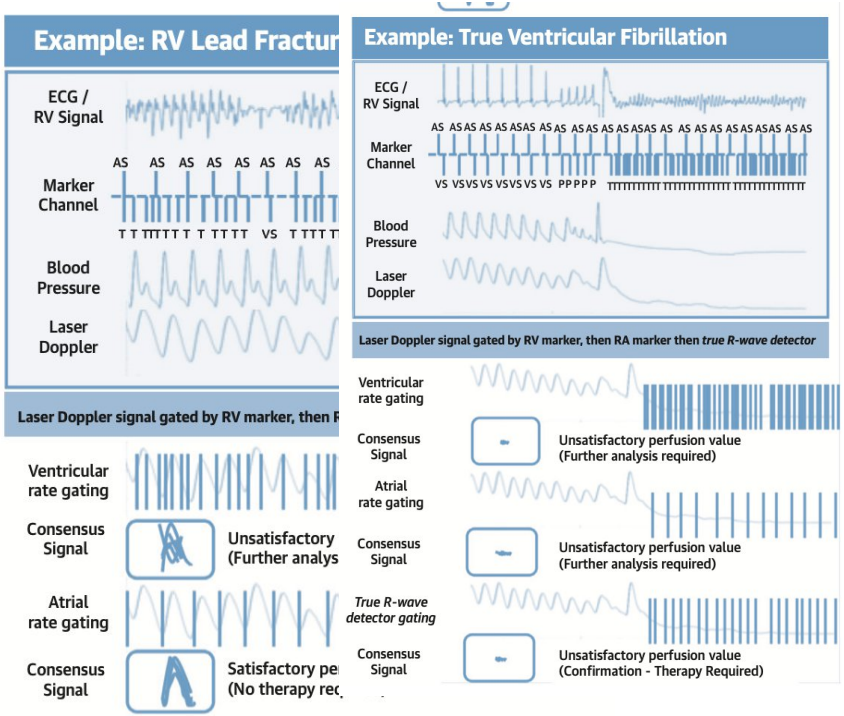
Variable	Active (n = 221)	Control (n = 212)	P
Recipients of			
≥1 appropriate or inappropriate shock	47 (21.3)	56 (26.4)	0.21
≥1 appropriate shock	37 (16.7)	37 (17.5)	0.84
≥1 inappropriate shock	11 (5.0)	22 (10.4)	0.03
1 inappropriate shock	7 (3.2)	12 (5.7)	0.21
2–9 inappropriate shocks	4 (1.8)	6 (2.8)	0.48
≥10 inappropriate shocks	0 (0)	4 (1.9)	0.04
All shocks delivered	193	657	
Appropriate	165	374	
Inappropriate	28	283	





Guedon-Moreau L, J Cardiovasc Electrophysiol 2014, 25:763-770

Quantification of Electromechanical Coupling to Prevent Inappropriate Implantable Cardioverter-Defibrillator Shocks: *The future?*



The study tested a novel processing algorithm that combines electrogram data and laser Doppler perfusion monitoring as a method for assessing circulatory status.

The electromechanical coupling algorithm found a clear perfusion cut off between sinus rhythm and VF (sensitivity and specificity of 100%).

Sensitivity and specificity remained at 100% during simulated lead fracture and electrogram oversensing.

Incorporating such methods into future ICDs may permit reductions of inappropriate shocks.

Keene D, J Am Coll Cardiol EP 2019;5:705–15

PLACE 9ª Edizione

Ecost Trial

Appropriate and Inappropriate Shocks Delivered in Each Study Group

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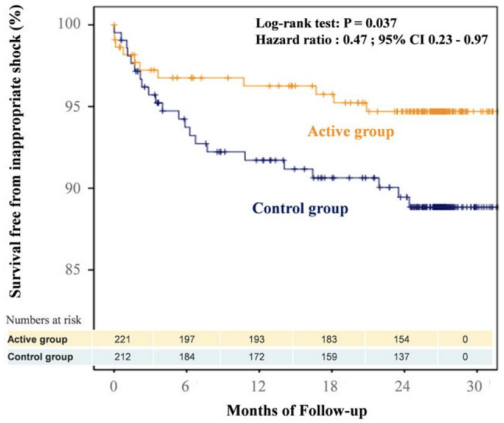

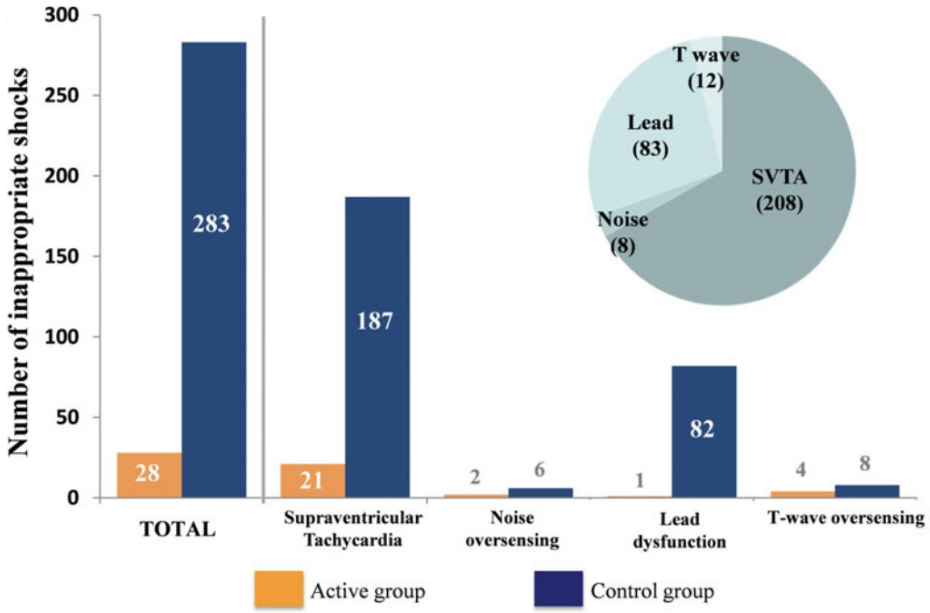

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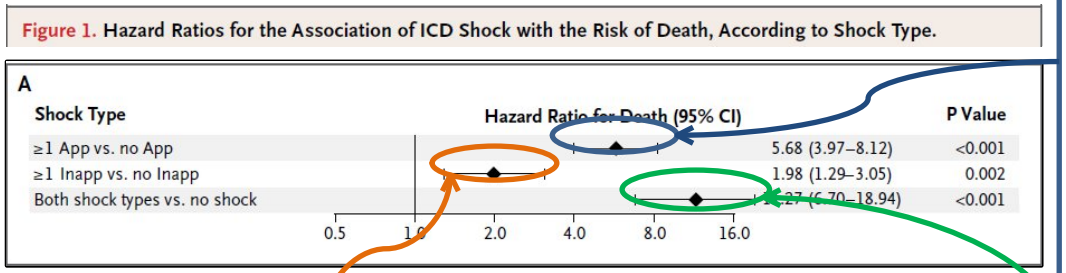
PLACE
PLATFORM OF LABORATORIES FOR ADVANCES IN CARDIAC EXPERIENCE

9ª Edizione

- La terapia dell'ICD si associa ad aumento della mortalità
  - MADIT II
    - shock appropriati associati a rischio di mortalità triplo e aumento delle ospedalizzazioni;
    - shock inappropriati associati a mortalità doppia
  - SCD-HeFT
    - shock appropriati e inappropiati associati rispettivamente a a rischio di morte di 6 e 2 volte superiore

Relazione causale tra terapia e aumentata mortalità o marker di cattiva prognosi?

HOWEVER ICD SHOCKS MAY INCREASE MORBIDITY AND MORTALITY



An **appropriate shock**, as compared with no appropriate shock, was associated with a risk that was increased by a **factor of more than 5**

An **inappropriate shock**, as compared with no inappropriate shock, was associated with a near **doubling of the risk of death.**

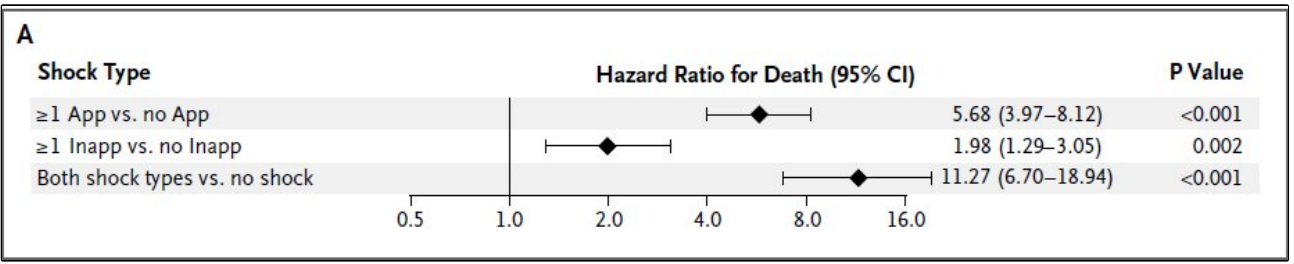
In patients who received **both shock types**, the **risk of death was increased by a factor of 11**, as compared with the risk in patients who received no shocks.

Poole JE,et al. N Engl J Med. 2008;359(10):1009-1017

Patients who receive shocks (appropriate and/or inappropriate) have a substantially **higher risk of death** than similar patients who do not receive any shocks.

The shocks paradox

Figure 1. Hazard Ratios for the Association of ICD Shock with the Risk of Death, According to Shock Type.



- SCD-HeFT
- An **appropriate shock**, as compared with no appropriate shock, was associated with a risk that was increased by a **factor of more than 5**
- An **inappropriate shock**, as compared with no inappropriate shock, was associated with a near **doubling of the risk of death.**

Poole JE, N Engl J Med. 2008;359(10):1009-1017

Prognostic impact

Table 6 Predictors of All-Cause Mortality by Cox Proportional Hazards Regression Analysis

Variable	Hazard Ratio	95% Confidence Interval	p Value
Baseline characteristics			
Blood urea nitrogen >25	2.07	1.38–3.11	<0.01
No beta-blocker	1.64	1.09–2.47	0.02
Interim events			
Interim CHF hospitalization	4.23	2.70–6.62	<0.01
Appropriate and inappropriate shock	4.08	1.71–9.75	<0.01
Appropriate shock only	3.36	2.04–5.55	<0.01
Inappropriate shock only	2.29	1.11–4.71	0.02
Appropriate and inappropriate therapy	3.12	1.38–7.03	<0.01
Appropriate therapy only	2.53	1.54–4.15	<0.01
Inappropriate therapy only	2.01	0.97–4.13	0.06
Appropriate ATP but not shock	0.412	0.148–1.150	0.0903
Inappropriate ATP but not shock	0.729	0.213–2.496	0.6145

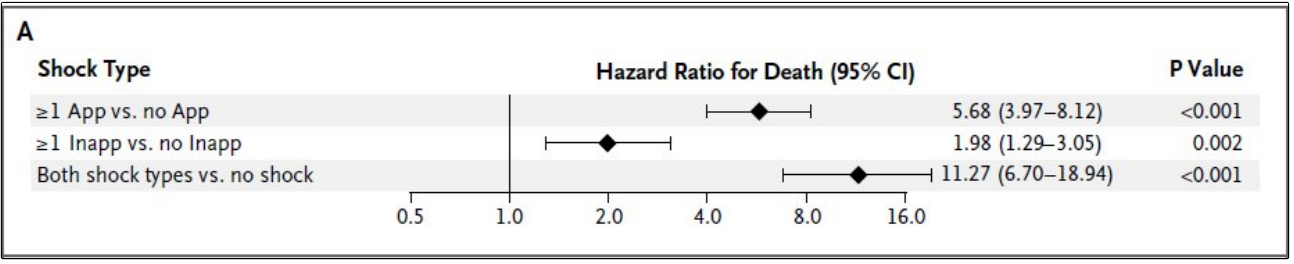


Figure 1. Hazard Ratios for the Association of ICD Shock with the Risk of Death, According to Shock Type.

- MADIT II
  appropriate shocks associated with a risk that was increased by a **factor of 3**

  inappropriate shock associated with a near **doubling of the risk of death.**
- SCD-HeFT
- An **appropriate shock**, as compared with no appropriate shock, was associated with a risk that was increased by a **factor of more than 5**
- An **inappropriate shock**, as compared with no inappropriate shock, was associated with a near **doubling of the risk of death.**

Poole JE, N Engl J Med. 2008;359(10):1009-1017
Daubert PJ, J Am Coll Cardiol 2008;51:1357–65)

Prognostic impact

– MADIT II

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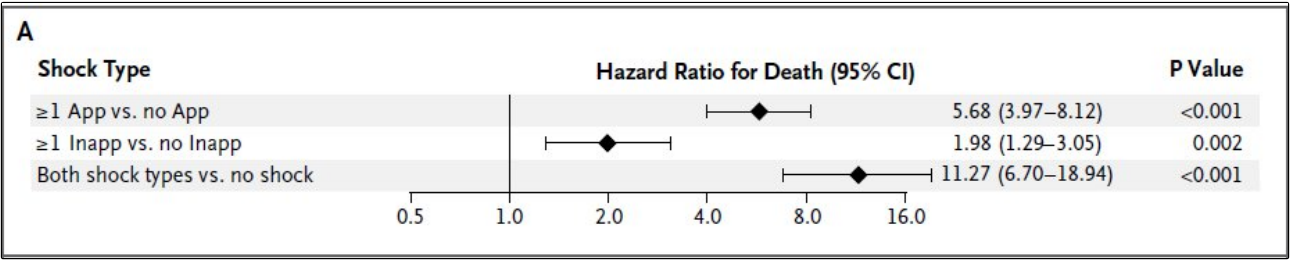


Figure 1. Hazard Ratios for the Association of ICD Shock with the Risk of Death, According to Shock Type.

– SCD-HeFT
– An **inappropriate shock** was associated with a near **doubling of the risk of death.**

Poole JE, N Engl J Med. 2008;359(10):1009-1017
Daubert PJ, J Am Coll Cardiol 2008;51:1357–65)

The NEW ENGLAND JOURNAL of MEDICINE
ESTABLISHED IN 1812 DECEMBER 13, 2012 VOL. 367 NO. 24

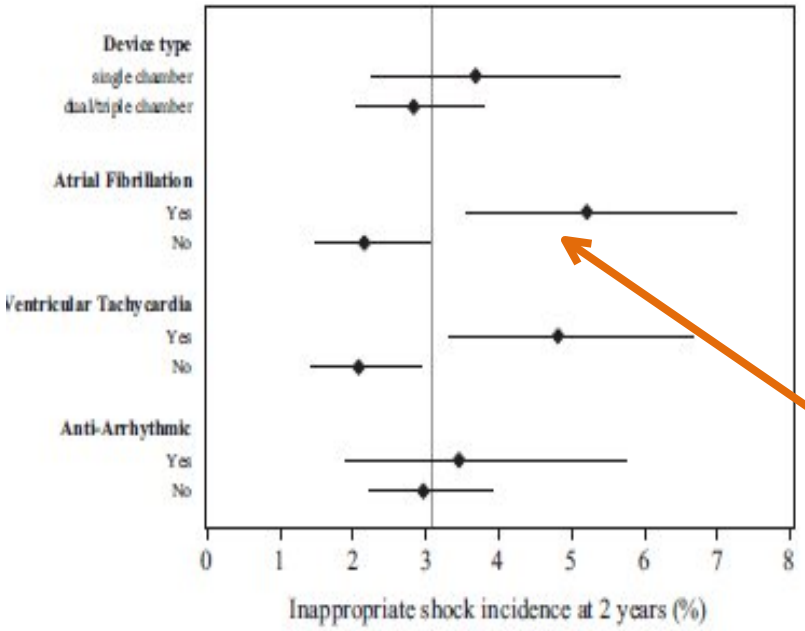
Reduction in Inappropriate Therapy and Mortality through ICD Programming

End point I: prima occorrenza di terapia inappropriata
End point II: morte per ogni causa e primo episodio di sincope

The purpose of this study was to assess IS reduction with the PARAD+ discrimination algorithm in a general population implanted for primary or secondary prevention.

1.Using **PARAD+ alone** in a wide spectrum of frequencies without the programming of a high cut-off rate and/or extended persistence, the annual patient incidence rate of IS ranged **from 1.0 (primary analysis) to 2.1 (worst-case analysis) per 100 person-years**.[5]

SUPRAVENTRICULAR TACHYCARDIA DISCRIMINATORS (PAINFREE SST)



•2.790 pts in primary prevention

Primary Endpoint : point was the percentage of patients receiving at least 1 inappropriate shock ***@ 12 months***

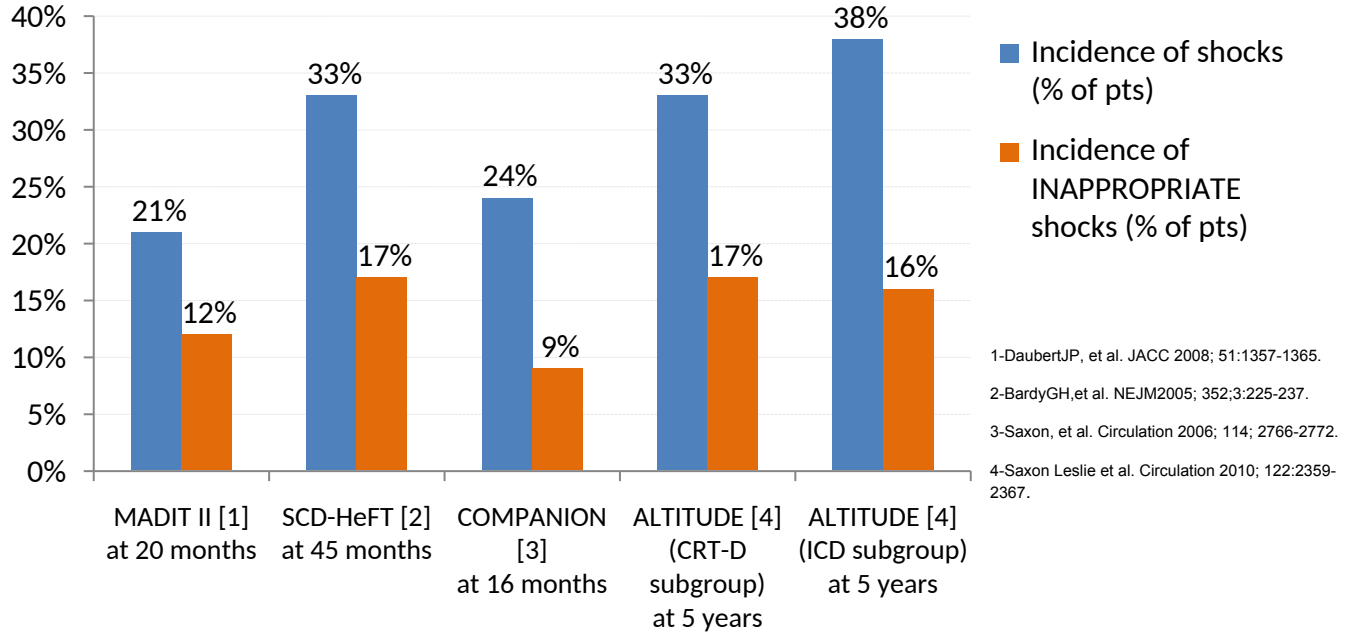
- Dual Chamber/CRTD Group = 2019
- Single Chamber Group = 751

Many inappropriate shochs was due to atrial fibrillation or flutter (49% in dual Chamber/CRT-D Group vs 81% in Single chamber Group)

Heart Rhythm, Vol 12, No 5, May 2015

PainFree SST trial find only a light trend in favor of Dual-Chamber discriminators in inappropriate shock reduction

INCIDENCE OF SHOCKS AND INAPPROPRIATE SHOCKS IN BIG TRIALS



1-DaubertJP, et al. JACC 2008; 51:1357-1365.

2-BardyGH,et al. NEJM2005; 352;3:225-237.

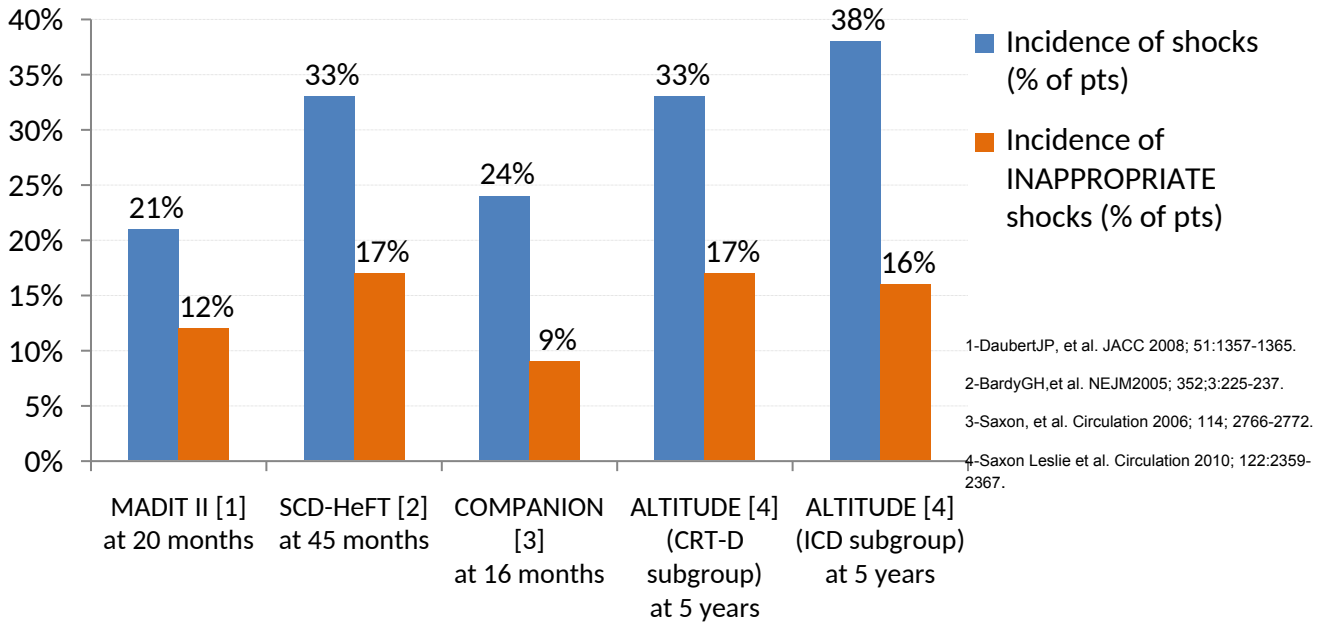
3-Saxon, et al. Circulation 2006; 114; 2766-2772.

4-Saxon Leslie et al. Circulation 2010; 122:2359-2367.

By 4-5 years, approximately, 1/3 of patients have experiences (at least) one shock episode with 16-18% receiving at least one inappropriate shock

How many shocks do ICD patients receive?

Incidence of shocks and inappropriate shocks in big trials



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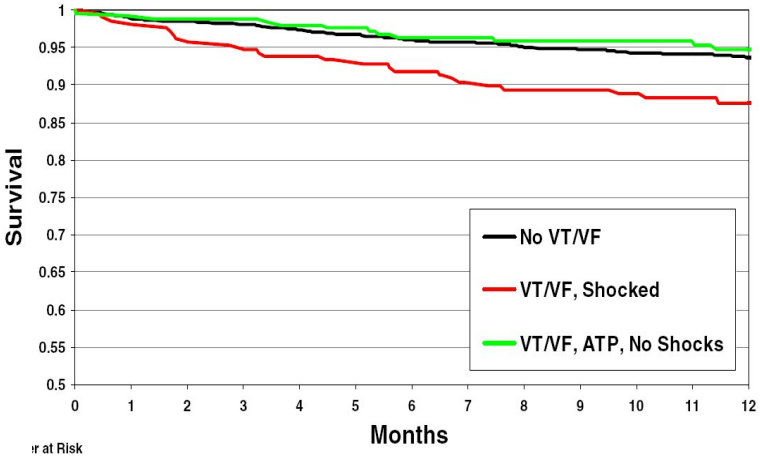
By 4-5 years, approximately, 1/3 of patients have experiences (at least) one shock episode with 16-18% receiving at least one inappropriate shock

agenda

- QUALITà DI VITA

SIGNIFICATO PROGNOSTICO DEGLI SHOCK

Analisi retrospettiva dei dati di: **PainFREE I e II, EMPIRIC e PREPARE**
2135 pz, FE media 31%, CAD 87%, NYHA II/III 55%, NYHA I/Non scompenso 42%



- Piu' alta mortalità in pazienti con episodi ventricolari e shock
- Shock inappropriati non associati ad aumento di mortalità

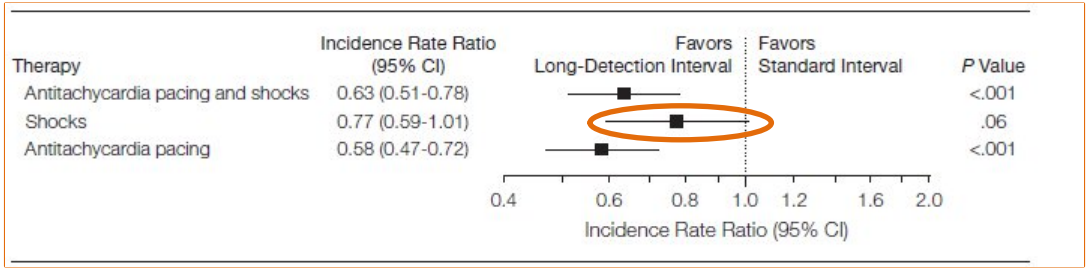
Sweeney et al, Heart Rhythm 2010; 7: 353-360

PROLONGATION OF ARRHYTHMIA DETECTION TIME (ADVANCE III)

•1.902 pts in primary & secondary prevention
• *ICD (VR+DR) & CRT-D population*
• *Primary Endpoint :* prolonged detection (30 /40 intervals) would lead to a 20% reduction in ICD therapies (ATP or shocks)

• Secondary *Endpoint* : evaluation of the percent reduction in the number of shocks delivered

Unlike previous studies, ADVANCE III included both primary and secondary prevention patients, with or without atrial fibrillation, in whom single-, dual- and triple-chamber ICD had been implanted



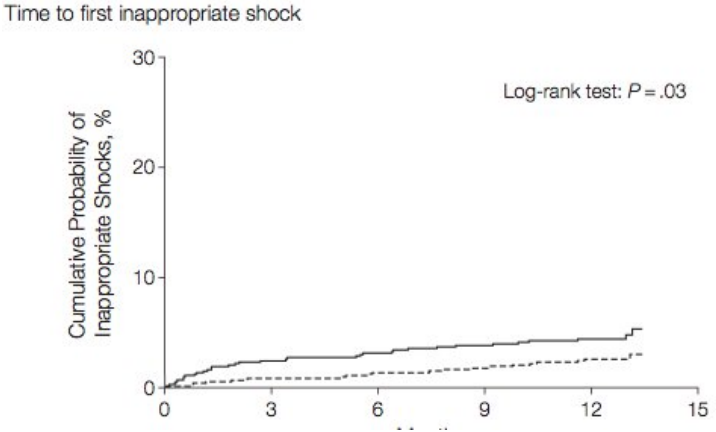
Gasparini M et al JAMA 2013

ADVANCE III demonstrated that **the use of a long detection setting significantly reduced the rate of ventricular therapies delivered and inappropriate shocks** compared with the standard detection settings.

EndpoinT II shocks appropriati e non appropriati

Table 3. Secondary End Point Appropriate and Inappropriate Shocks Results According to Intention-to-Treat Analyses[a]

	Exposure, per Patient-Year)	No. of Ventricular Arrhythmias	No. of Therapies Delivered[b]	No. of Patients	Shock Rate per 100 Patient-Year (95% CI)	IRR (95% CI)[c]	*P* Value
Intention to Treat – Appropriate Shocks							
Standard-interval detection	830	230	147	58	18 (15-20)	1	.80
Long detection	826	163	110	55	13 (11-16)	0.95 (0.67-1.37)	
Intention to Treat – Inappropriate Shocks							
Standard-interval detection	830	85 Inappropriate detections	96	39	11 (9-14)	1	.008
Long detection	826	40 Inappropriate detections	42	22	5 (4-7)	0.55 (0.36-0.85)	



OBJECTIVE The purpose of the PainFree SmartShock Technology (SST) study was to investigate new-generation ICDs to reduce inappropriate and unnecessary shocks through novel discrimination algorithms with modern programming strategies.

the adoption of novel enhanced detection algorithms in conjunction with routine implementation of modern programming strategies led to a very low inappropriate shock rate.

The S-ICD Evolution at a glance >> 100000 patients worldwide

PLACE 9ª Edizione
PLATFORM OF LABORATORIES FOR ADVANCES IN CARDIAC EXPERIENCE

1ª Generazione

UNTOUCHED - arruolamento di 2000 pazienti

Studio randomizzato **PRAETORIAN** – arruolamento di 850 pazienti

EFFORTLESS 1000 pazienti

Studio per il marchio CE[1] 55 pazienti

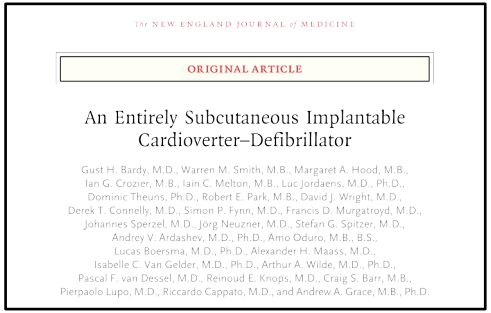
Sperimentazione **IDE** 132 pazienti

US Registry: 3717 pts
Friedman DJ; JAMA Cardiol. 2016;1(8):900-911

- 2 incision tech.
- Intermuscolar appr.
- Automated screening

New 3501 lead

2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

An Entirely Subcutaneous Implantable Cardioverter–Defibrillator

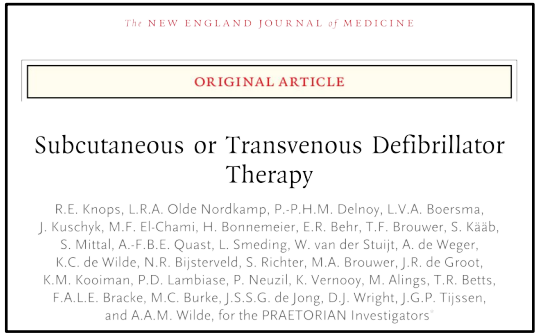
Gust H. Bardy, M.D., Warren M. Smith, M.B., Margaret A. Hood, M.B., Ian G. Crozier, M.B., Iain C. Melton, M.B., Luc Jordaens, M.D., Ph.D., Dominic Theuns, Ph.D., Robert E. Park, M.B., David J. Wright, M.D., Derek T. Connelly, M.D., Simon P. Fynn, M.D., Francis D. Murgatroyd, M.D., Johannes Sperzel, M.D., Jörg Neuzner, M.D., Stefan G. Spitzer, M.D., Andrey V. Ardashev, M.D., Ph.D., Arno Oduro, M.B., B.S., Lucas Boersma, M.D., Ph.D., Alexander H. Maass, M.D., Isabelle C. Van Gelder, M.D., Ph.D., Arthur A. Wilde, M.D., Ph.D., Pascal F. van Dessel, M.D., Reinoud E. Knops, M.D., Craig S. Barr, M.B., Pierpaolo Lupo, M.D., Riccardo Cappato, M.D., and Andrew A. Grace, M.B., Ph.D.

2ª Generazione

Inclusion in AHA/ACC/HRS guidelines (Class I)

Inclusion in ESC guidelines (Class IIA)

PRAETORIAN UNTOUCHED PUBLISHED (1542 pts)



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Subcutaneous or Transvenous Defibrillator Therapy

R.E. Knops, L.R.A. Olde Nordkamp, P.-P.H.M. Delnoy, L.V.A. Boersma, J. Kuschyk, M.F. El-Chami, H. Bonnemeier, E.R. Behr, T.F. Brouwer, S. Kääb, S. Mittal, A.-F.B.E. Quast, L. Smeding, W. van der Stuijt, A. de Weger, K.C. de Wilde, N.R. Bijsterveld, S. Richter, M.A. Brouwer, J.R. de Groot, K.M. Kooiman, P.D. Lambiase, P. Neuzil, K. Vernooy, M. Alings, T.R. Betts, F.A.L.E. Bracke, M.C. Burke, J.S.S.G. de Jong, D.J. Wright, J.G.P. Tijssen, and A.A.M. Wilde, for the PRAETORIAN Investigators