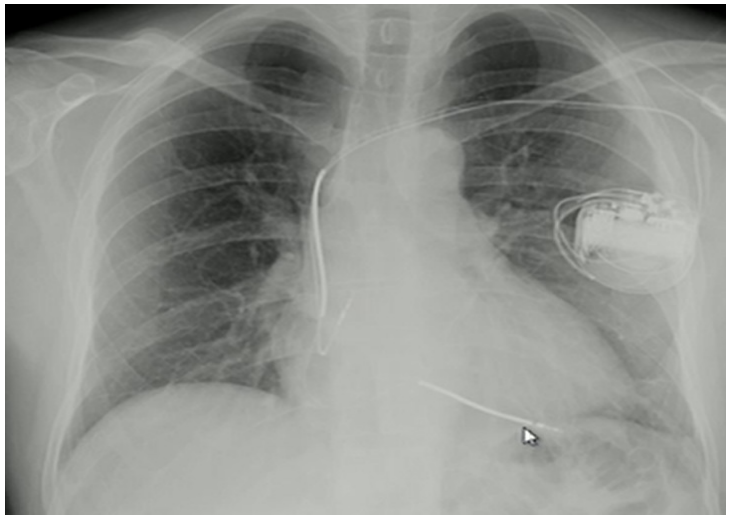
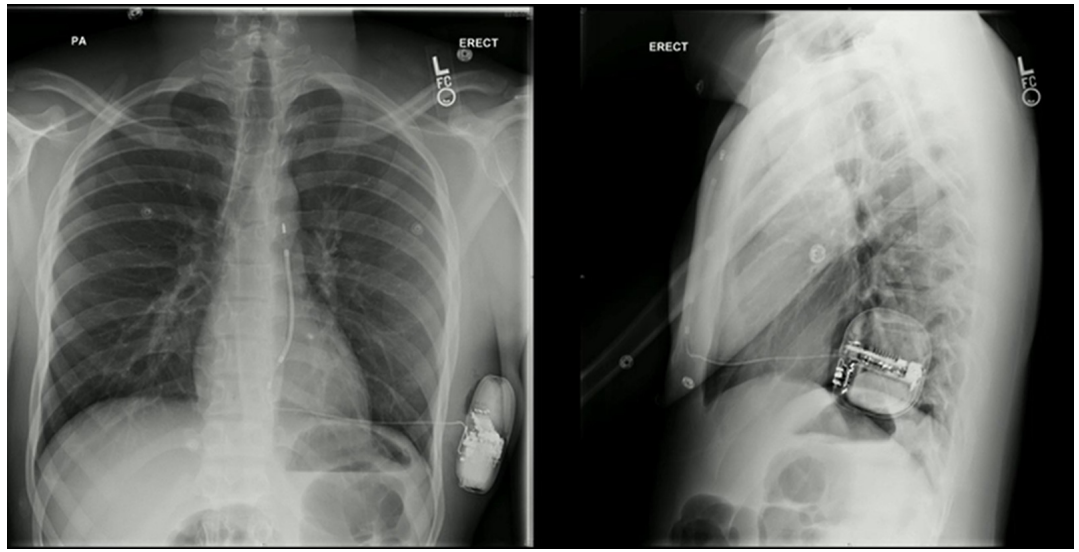
08:30-09:25	**Pil ve ICD Programlama** **Oturum Başkanları:** Ahmet Vural, Aslı Atar
08:30-08:45	Pacemaker Zaman Aralıkları - **Evrim Şimşek**
08:45-09:00	Optimal Pacemaker Programlama - **Ömer Alyan**
09:00-09:15	Optimal ICD Programlama - **Meryem Kara**
09:15-09:25	Tartışma

Uzm.Dr.Meryem KARA
Ankara Şehir Hastanesi
Aritmi Kliniği


AUTOMATIC
IMPLANTABLE
DEFIBRILLATOR
Model AID-II
INTEC SYSTEMS


EMBLEM MRI
S-ICD
A219
NOT FOR HUMAN USE
Medtronic
RESONATE EL
Boston Scientific
X4 CRT-D
Boston Scientific
Medtronic
Reveal LINQ
ImageReady
MR Conditional
Pacing System
Boston Scientific
Medtronic
Azure MRI SureScan

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Europace (2016) **18**, 159–183
doi:10.1093/europace/euv411

CONSENSUS STATEMENT

2015 HRS/EHRA/APHRS/SOLAECE expert consensus statement on optimal implantable cardioverter-defibrillator programming and testing

Europace (2019) **21**, 1442–1443
doi:10.1093/europace/euz065

EHRA POSITION PAPER

2019 HRS/EHRA/APHRS/LAHRS focused update to 2015 expert consensus statement on optimal implantable cardioverter-defibrillator programming and testing

Optimal ICD programlaması

- Bradikardi (mod, hız, RV pacing – CRT ve non-CRT)
- Taşikardi tanımlama (hız, süre, kısıtlılıklar)
- VT/SVT ayrımı (geliştirilmiş saptama kriterleri ve algoritmalar)
- Taşikardi tedavisi (ATP, şok)

Bradycardia mode and rate programming recommendations	Class of recommendation	Level of evidence
In ICD patients who also have sinus node disease and guideline-supported indications for a bradycardia pacemaker, it is beneficial to provide dual-chamber pacing to reduce the risk of AF and stroke, to avoid pacemaker syndrome, and to improve quality of life.	I	B-R
In single- or dual-chamber ICD patients without guideline-supported indications for bradycardia pacing, adjusting the pacing parameters is recommended so that ventricular stimulation is minimized to improve survival and reduce HF hospitalization.	I	B-R
In ICD patients who have sinus rhythm, no or only mild LV dysfunction, and AV block where ventricular pacing is expected, it is reasonable to provide dual-chamber pacing in preference to single-chamber ventricular pacing to avoid pacemaker syndrome and to improve quality of life.	IIa	B-R
In ICD patients who have sinus rhythm, mild to moderate LV dysfunction, and AV block where ventricular pacing is expected, it is reasonable to provide CRT in preference to dual-chamber ventricular pacing to improve the combination of HF hospitalization, LV enlargement, and death.	IIa	B-R
In ICD patients who have chronotropic incompetence, it can be beneficial to programme the ICD to provide sensor-augmented rate response, especially if the patient is young and physically active.	IIa	B-NR
In dual-chamber ICD patients with native PR intervals of $\leq$230 ms, it can be beneficial to programme the mode, automatic mode change, and rate response, so the patient's native AV conduction minimizes ventricular pacing.	IIa	B-R
In biventricular pacing ICD patients, it can be beneficial to adjust the therapy to produce the highest achievable percentage of ventricular pacing, preferably $>$98%, to improve survival and reduce HF hospitalization.	IIa	B-NR
In biventricular pacing ICD patients, it can be reasonable to activate the algorithms providing automatic adjustment of AV delay and/or LV–RV offset to obtain a high percentage of synchronized pacing and reduce the incidence of clinical events.	IIb	B-R

Circulation
Volume 122, Issue 13, 28 September 2010; Pages 1265-1271
https://doi.org/10.1161/CIRCULATIONAHA.110.940148

ARRHYTHMIA/ELECTROPHYSIOLOGY

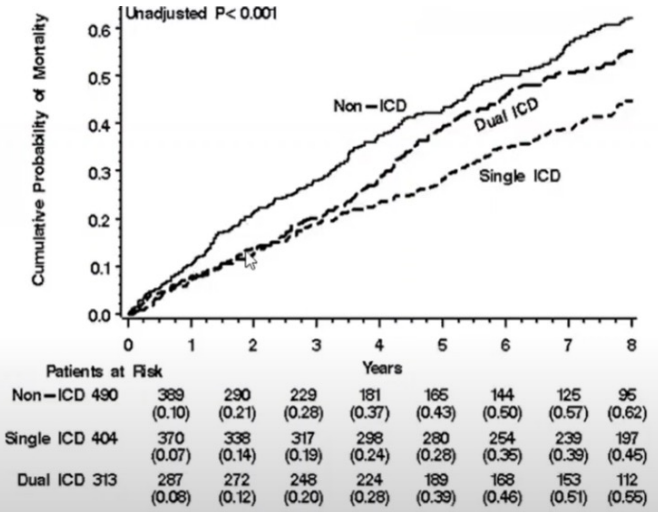
Long-Term Benefit of Primary Prevention With an Implantable Cardioverter-Defibrillator

An Extended 8-Year Follow-Up Study of the Multicenter Automatic Defibrillator Implantation Trial II

Long-Term Benefit of Primary Prevention ICD

8-Year Follow-Up Study of MADIT II

Over time, mortality in patients with a Dual Chamber ICD veers away from single chamber ICDs



Goldenberg, I., et al. (2010). Circulation **122**(13): 1265-1271.

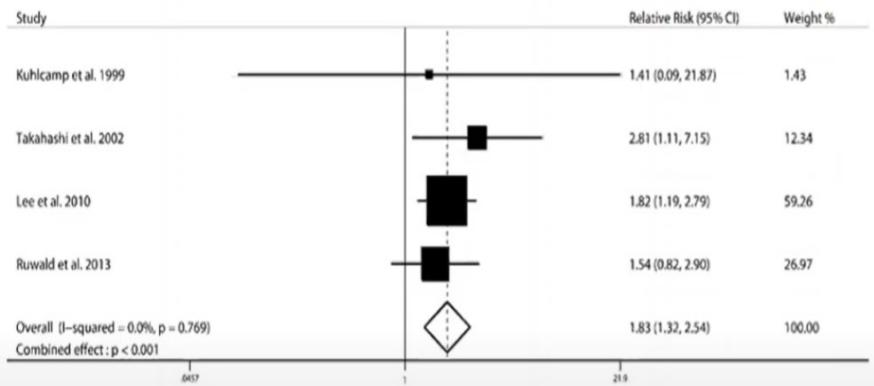
Heart Rhythm Disorders

The DAVID (Dual Chamber and VVI Implantable Defibrillator) II Trial

Bruce L. Wilkoff, MD, FACC,* Peter J. Kudenchuk, MD, FACC,† Alfred E. Buxton, MD, FACC,‡ Arjun Sharma, MD,§ James R. Cook, MD, FACC,‖ Anil K. Bhandari, MD, FACC,¶ Michael Biehl, MD, FACC,# Gery Tomassoni, MD,** Anna Leonen, MS,† Linette R. Klevan, RN,†† Alfred P. Hallstrom, PHD,† for the DAVID II Investigators

Cleveland, Ohio; Seattle, Washington; Providence, Rhode Island; St. Paul, Minnesota; Springfield, Massachusetts; Los Angeles, California; Paterson, New Jersey; Lexington, Kentucky; and Norfolk, Virginia

VVI vs DDD ICDs - meta-analysis of complications



No difference in all-cause mortality
No difference in inappropriate Rx
More complications (RR=1.83, p<0.001)

Chen, B.-W., et al. (2014). JICE **39**(3): 273-280.

Ne kadar fazla lead, o kadar problem;

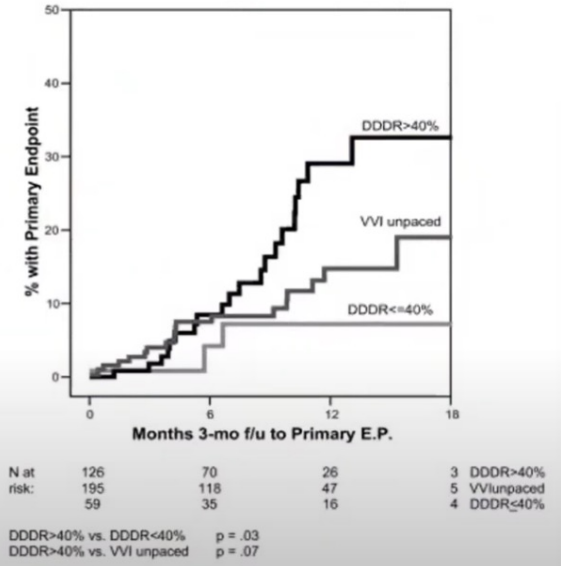
- Daha fazla implantasyon komplikasyonu
- Daha fazla lead problemi ihtimali
- Daha fazla pacing
- Daha az pil ömrü
- Daha yüksek maliyet

Percent right ventricular pacing predicts outcomes in the DAVID trial

Arjun D. Sharma, MD,[a] Carlos Rizo-Patron, MD,[b] Alfred P. Hallstrom, PhD,[c] Gearoid P. O'Neill, MD,[a] Stephen Rothbart, MD,[d] James B. Martins, MD,[e] Marc Roelke, MD,[f] Jonathan S. Steinberg, MD,[g] H. Leon Greene, MD,[c] and the DAVID Investigators

Percent RV pacing predicted Death/HFH in DAVID landmark analysis

- % RV pacing predictive after adjustment for baseline HR, age and AV-PR



Sharma, A. D., et al. (2005) Heart Rhythm **2**(8): 830-834.

The Clinical Implications of Cumulative Right Ventricular Pacing in the Multicenter Automatic Defibrillator Trial II

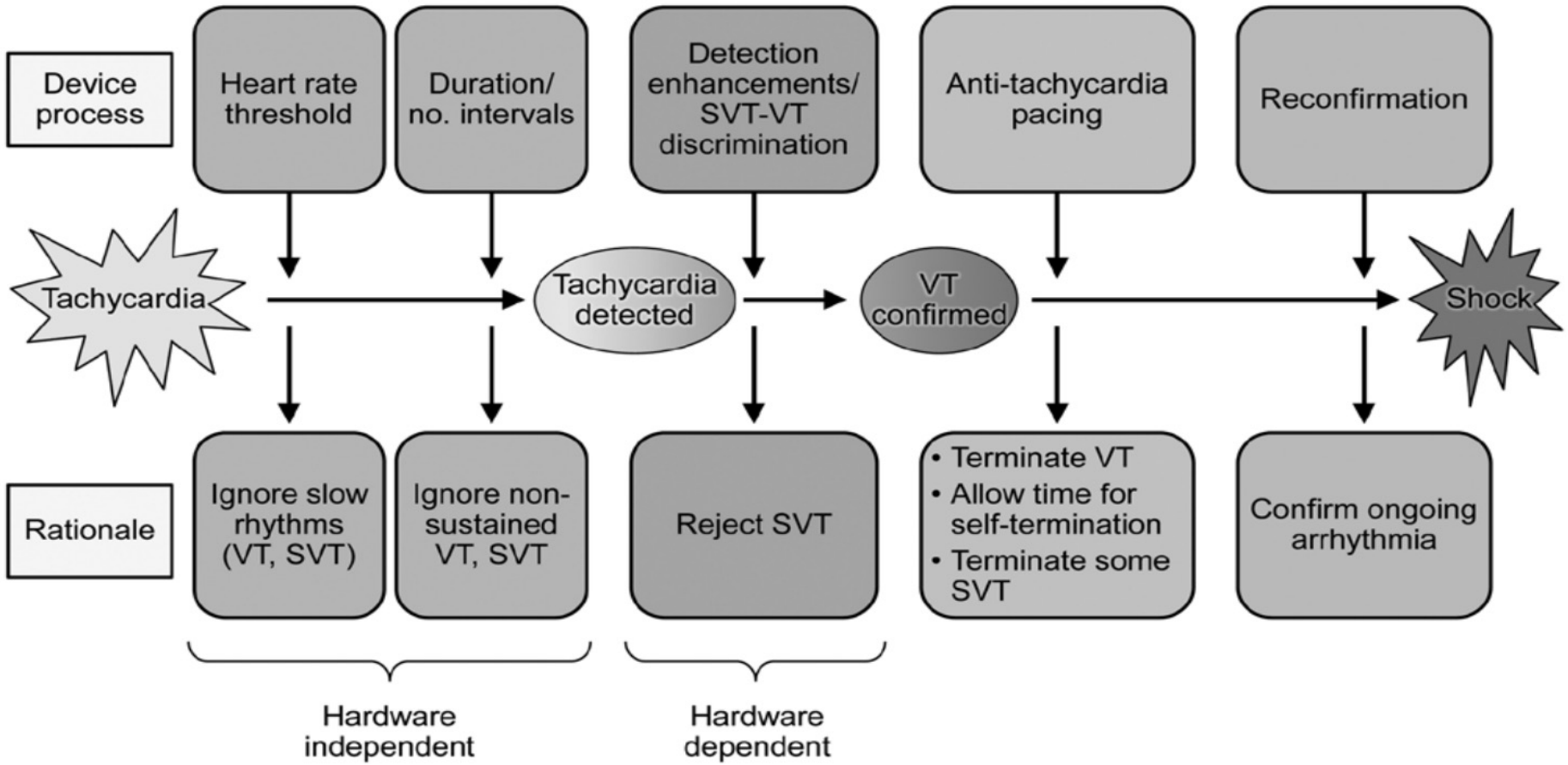
JONATHAN S. STEINBERG, M.D.,* AVI FISCHER, M.D.,* PAUL WANG, M.D.,#
CLAUDIO SCHUGER, M.D.,¶ JAMES DAUBERT, M.D.,§ SCOTT MCNITT, M.S.,§
MARK ANDREWS, B.B.A.,§ MARY BROWN, M.S.,§ W. JACKSON HALL, PH.D.,§
WOJCIECH ZAREBA, M.D.,§ and ARTHUR J. MOSS, M.D.,§ for the MADIT II Investigators**

RV pacing yükünün >%50 olduğu hastalarda daha yüksek KY riski

Yüksek RV pacing yükü (RV pacing >%50) KY riskinde artış ve uygun ICD şokları ile ilişkili

Right ventricular pacing and the risk of heart failure in implantable cardioverter-defibrillator patients

Marcelle D. Smit, MSc,* Pascal F.H.M. Van Dessel, MD, PhD,* Wybe Nieuwland, MD, PhD,*
Ans C.P. Wiesfeld, MD, PhD,* Eng S. Tan, MD,* Rutger L. Anthonio, MD, PhD,*
Lieselot Van Erven, MD, PhD,† Dirk J. Van Veldhuisen, MD, PhD, FACC,*
Isabelle C. Van Gelder, MD, PhD*


Device process
Heart rate threshold
Duration/ no. intervals
Detection enhancements/ SVT-VT discrimination
Anti-tachycardia pacing
Reconfirmation
Tachycardia
Tachycardia detected
VT confirmed
Shock
Rationale
Ignore slow rhythms (VT, SVT)
Ignore non-sustained VT, SVT
Reject SVT
• Terminate VT
• Allow time for self-termination
• Terminate some SVT
Confirm ongoing arrhythmia
Hardware independent
Hardware dependent

Taşikardi tanımlama kalp hızı ve süresi

- ICD'lerin amacı ventriküler taşiaritmileri tanımlayıp aritmilerin uygun şekilde tedavi edilmesidir.
- ICD 'lerin ventriküler taşiaritmi tanımlaması; kalp hızı eşik değerine ve taşikardi süresine dayanır.
- Taşikardi saptandıktan sonra algoritmalar devreye girer.

- Ventriküler aritmiler tanımlanırken supraventriküler aritmiler, T wave oversensing veya diğer artefakt sinyaller yanlış saptanması uygunsuz şoklara neden olabilmektedir.
- Uygunsuz şoklardan kaynaklanan mortalite dahil potansiyel zarara ilişkin farkındalığın artması ve EGM kayıtlarında VT epizodlarının spontan sonlanabileceğinin anlaşılması, sadece hıza bağlı olmayan uzun süreli tespit stratejilerine ve birçok algoritma geliştirilmesine yönlendirmiştir.

- İyi bir programlama ile uygunsuz şokları azaltırken ölümcül olabilecek ventriküler aritmilerin etkin tedavisi de sağlanmalıdır.
- Ancak algoritma kullanılırken VT tanınmasının da güçleştirebileceğimizi akılda tutmak gereklidir. (eksik algılama, uzamış süreile ilişkili senkop ataklar, uzamış VF süresiyle birlikte artan defibrilasyon eşiği….)

Tachycardia detection programming recommendations	Class of recommendation	Level of evidence
For primary-prevention ICD patients, tachyarrhythmia detection duration criteria should be programmed to require the tachycardia to continue for at least 6–12 s* or for 30 intervals before completing detection, to reduce total therapies. **Tachyarrhythmia detection duration is directly related to the tachyarrhythmia rate. Direct evidence to support a delay of >2.5 s for rates over 250 bpm is not available, but can be inferred from evidence that 30 detection intervals are safe at that rate.*	I	A
For primary-prevention ICD patients, the slowest tachycardia therapy zone limit should be programmed between 185 and 200 bpm*, to reduce total therapies. **Higher minimum rates for detection might be appropriate for young patients or for those in whom SVT-VT discriminators cannot reliably distinguish SVT from VT, provided that there is no clinical VT below this rate.*	I	A
For secondary-prevention ICD patients, tachyarrhythmia detection duration criteria should be programmed to require the tachycardia to continue for at least 6–12 s* or for 30 intervals before completing detection, to reduce total therapies. **Tachyarrhythmia detection duration is directly related to the tachyarrhythmia rate. Direct evidence to support a delay of >2.5 s for rates over 250 bpm is not available, but can be inferred from evidence that 30 detection intervals are safe at that rate.*	I	B-R
Discrimination algorithms to distinguish SVT from VT should be programmed to include rhythms with rates faster than 200 bpm and potentially up to 230 bpm (unless contraindicated*) to reduce inappropriate therapies. **Discrimination algorithms and/or their individual components are contraindicated in patients with complete heart block or if the algorithm/component is known to be unreliable in an individual patient. Dual-chamber discriminators that misclassify VT as SVT if the atrial lead dislodges are discouraged in the perioperative period. Dual-chamber discriminators are contraindicated in patients with known atrial lead dislodgment, atrial undersensing or oversensing of far-field R waves, and in those with permanent AF.*	I	B-R
It is recommended to activate lead failure alerts to detect potential lead problems.	I	B-NR

For secondary-prevention ICD patients where the clinical VT rate is known, it is reasonable to programme the slowest tachycardia therapy zone at least 10 bpm below the documented tachycardia rate but not faster than 200 bpm*, to reduce total therapies. **Higher minimum rates for detection might be appropriate for young patients or for those in whom SVT-VT discriminators cannot reliably distinguish SVT from VT, provided that there is no clinical VT below this rate.*	IIa	C-EO
It can be useful to programme more than one tachycardia detection zone to allow effective use of tiered therapy and/or SVT-VT discriminators and allow for a shorter delay in time-based detection programming for faster arrhythmias.	IIa	B-R
When a morphology discriminator is activated, it is reasonable to re-acquire the morphology template when the morphology match is unsatisfactory, to improve the accuracy of the morphology discriminator.	IIa	C-LD
It is reasonable to choose single-chamber ICD therapy in preference to dual-chamber ICD therapy if the sole reason for the atrial lead is SVT discrimination, unless a known SVT exists that may enter the VT treatment zone, to reduce both lead-related complications and the cost of ICD therapy.	IIa	B-NR
For the S-ICD, it is reasonable to programme 2 tachycardia detection zones: 1 zone with tachycardia discrimination algorithms from a rate of $\leq$200 bpm and a second zone without tachycardia discrimination algorithms from a rate of $\geq$230 bpm, to reduce avoidable shocks.	IIa	B-NR
Programming a non-therapy zone for tachycardia monitoring might be considered to alert clinicians to untreated arrhythmias.	IIb	B-NR
It may be reasonable to disable the SVT discriminator time-out function, to reduce inappropriate therapies.	IIb	C-EO
It may be reasonable to activate lead 'noise' algorithms that withhold shocks when detected VT/VF is not confirmed on a shock or other far-field channel to avoid therapies for non-physiological signals.	IIb	C-EO
It may be reasonable to activate T-wave oversensing algorithms, to reduce inappropriate therapies.	IIb	C-LD
It may be reasonable to programme the sensing vector from bipolar to integrated bipolar in true bipolar leads at risk for failure of the cable to the ring electrode to reduce inappropriate therapies.* **This is not intended as a long-term solution when a cable fracture has been identified.*	IIb	C-EO

For primary prevention ICD patients, tachyarrhythmia detection duration criteria should be programmed to require the tachycardia to continue for at least 6-12 seconds* or for 30 intervals before completing detection, to reduce total therapies.

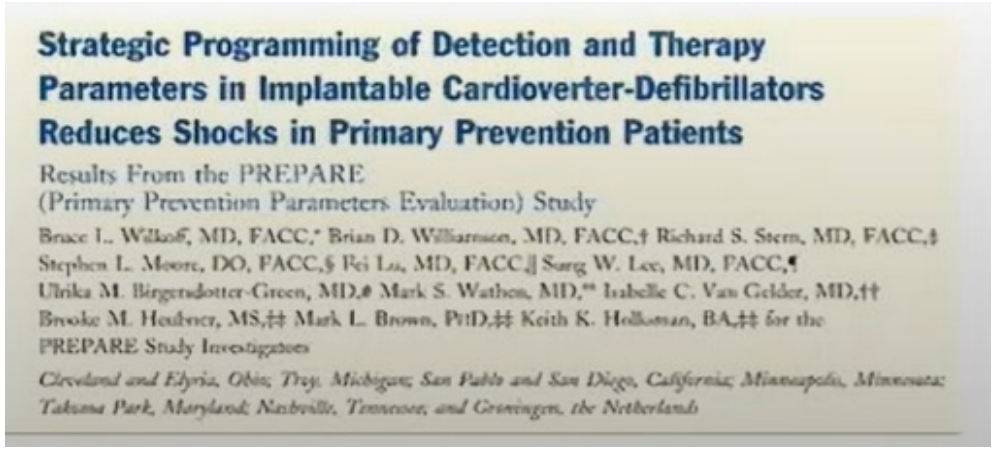
Non-randomize data

- PREPARE ve RELEVANT 30/40 int ; 12/16 int den daha iyi

Randomize data

- MADIT-RIT 12 sn ; 2.5 sn den daha iyi
- ADVANCE-3 30/40 int ; 18/24 int den daha iyi
- PROVİDE 25 int ; 12 int den daha iyi

- **PREPARE'de programlamayla, supraventriküler aritmi için uygunsuz şoklarda ve VT için önlenebilir şoklarda azalma gösterildi.**
- **Ayrıca composite endpoint ; morbidite, şok, senkop ve untreated sustained VT azalma**



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

Bruce L. Wilkoff, MD, FACC,* Brian D. Williamson, MD, FACC,† Richard S. Stern, MD, FACC,‡ Stephen L. Moore, DO, FACC,§ Fei Lu, MD, FACC,‖ Sung W. Lee, MD, FACC,¶ Ulrika M. Birgersdotter-Green, MD,# Mark S. Wathen, MD,** Isabelle C. Van Gelder, MD,†† Brooke M. Hoefner, MS,‡‡ Mark L. Brown, PhD,‡‡ Keith K. Holloman, BA,‡‡ for the PREPARE Study Investigators

Cleveland and Elyria, Ohio; Troy, Michigan; San Pablo and San Diego, California; Minneapolis, Minnesota; Takoma Park, Maryland; Nashville, Tennessee; and Groningen, the Netherlands

- **PREPARE'de olduğu gibi, RELEVANT çalışma da senkop insidansını artırmadan ICD tedavi yükünü önemli azalma (%81)**

European Heart Journal (2009) **30**, 2758–2767
doi:10.1093/eurheartj/ehp247

CLINICAL RESEARCH
Arrhythmia/electrophysiology

A simplified biventricular defibrillator with fixed long detection intervals reduces implantable cardioverter defibrillator (ICD) interventions and heart failure hospitalizations in patients with non-ischaemic cardiomyopathy implanted for primary prevention: the RELEVANT [Role of long dEtection window programming in patients with LEft VentriculAr dysfunction, Non-ischemic eTiology in primary prevention treated with a biventricular ICD] study

Reduction in Inappropriate Therapy and Mortality through ICD Programming

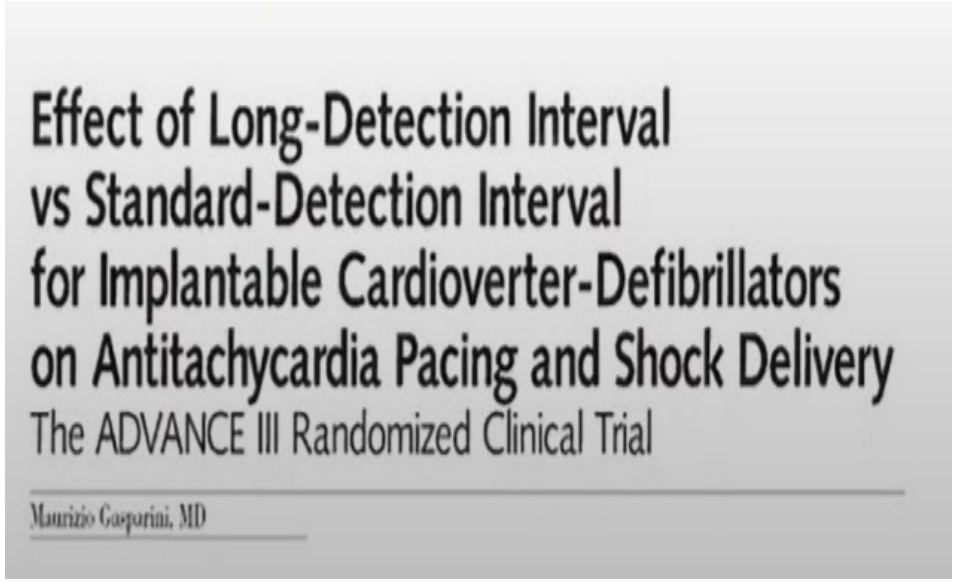
Arthur J. Moss, M.D., Claudio Schuger, M.D., Christopher A. Beck, Ph.D., Mary W. Brown, M.S., David S. Cannom, M.D., James P. Daubert, M.D., N.A. Mark Estes III, M.D., Henry Greenberg, M.D., W. Jackson Hall, Ph.D.,* David T. Huang, M.D., Josef Kautzner, M.D., Ph.D., Helmut Klein, M.D., Scott McNitt, M.S., Brian Olshansky, M.D., Morio Shoda, M.D., David Wilber, M.D., and Wojciech Zareba, M.D., Ph.D., for the MADIT-RIT Trial Investigators†

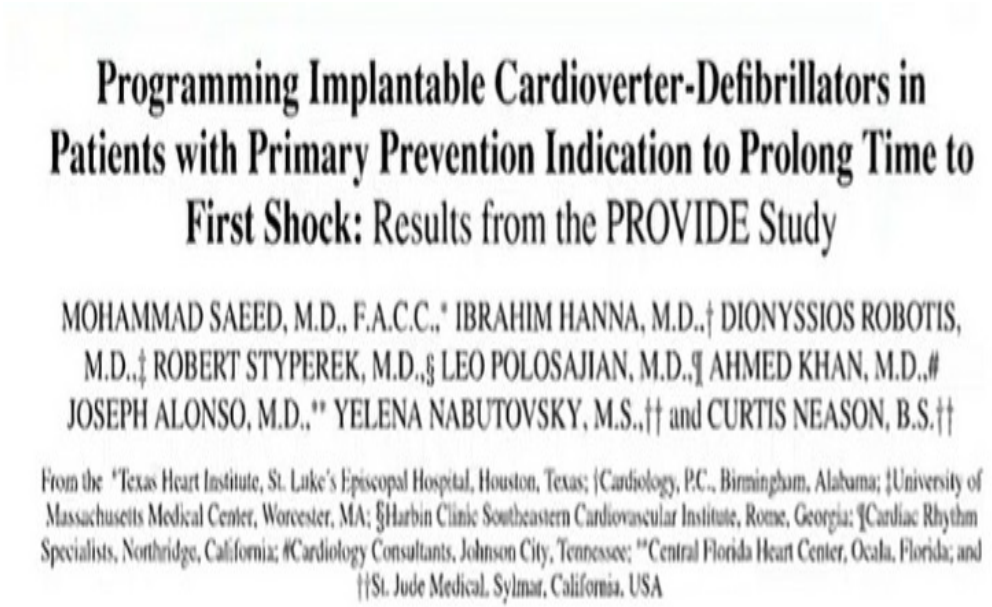
MADIT-RIT

Arm A (Conventional)	Arm B (High-rate)	Arm C (Duration-delay)
Zone 1:	Zone 1:	Zone 1:
≥170 bpm, 2.5s delay	**170 bpm**	**≥170 bpm, 60s delay**
Onset/Stability Detection Enhancements ON	Monitor only	Rhythm ID® Detection Enhancements ON
ATP + Shock		ATP + Shock
SRD 3 min initial		SRD Off
Zone 2:	Zone 2:	Zone 2:
≥200 bpm, 1s delay	**≥200 bpm, 2.5s delay**	**≥200 bpm, 12s delay**
Quick Convert™ ATP Shock	Quick Convert™ ATP Shock	Rhythm ID® Detection Enhancements ON
		ATP + Shock
		SRD Off
		Zone 3:
		≥250 bpm, 2.5s delay
		Quick Convert™ ATP + Shock

- **Prolonged detection group (Arm C) was associated with a reduction in treated VT/VF leading to a 76% reduction in the primary endpoint of the first inappropriate therapy (P , 0.001), as well as a significant reduction in the first appropriate therapy, appropriate ATP, and inappropriate ATP, but not in appropriate or inappropriate shock**

- **Uzun süreli tanımlama, tüm tedavilerde (uygun ve uygunsuz ATP'ler ve/veya şoklar), uygunsuz şoklarda ve tüm nedenlere bağlı hastaneye yatışlarda önemli bir azalma ile ilişkili**
- **Uzun süreli tanımlama ve standart programlama grupları arasında mortalite açısından anlamlı bir fark yok**





Programming Implantable Cardioverter-Defibrillators in Patients with Primary Prevention Indication to Prolong Time to First Shock: Results from the PROVIDE Study

MOHAMMAD SAEED, M.D., F.A.C.C.,* IBRAHIM HANNA, M.D.,† DIONYSSIOS ROBOTIS, M.D.,‡ ROBERT STYPEREK, M.D.,§ LEO POLOSAJIAN, M.D.,¶ AHMED KHAN, M.D.,# JOSEPH ALONSO, M.D.,** YELENA NABUTOVSKY, M.S.,†† and CURTIS NEASON, B.S.††

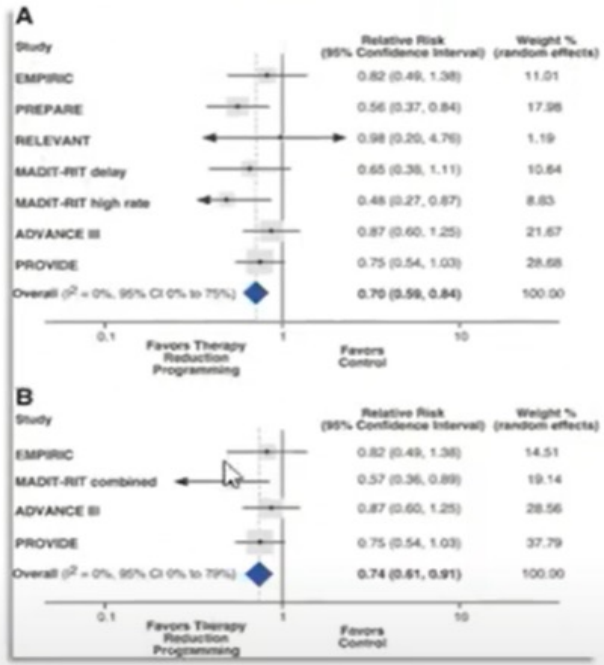
From the *Texas Heart Institute, St. Luke's Episcopal Hospital, Houston, Texas; †Cardiology, P.C., Birmingham, Alabama; ‡University of Massachusetts Medical Center, Worcester, MA; §Harbin Clinic Southeastern Cardiovascular Institute, Rome, Georgia; ¶Cardiac Rhythm Specialists, Northridge, California; #Cardiology Consultants, Johnson City, Tennessee; **Central Florida Heart Center, Ocala, Florida; and ††St. Jude Medical, Sylmar, California, USA

- **2 yıllık tüm nedenlere bağlı şok oranında %36 oranında önemli azalma ve hayatta kalma oranlarında iyileşme ile ilişkili**

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

Therapy Reducing Strategies-Detection Benefits of Waiting

Therapy reduction vs conventional programming and risk of death, randomized and nonrandomized studies.



Mortality

Therapy reduction programming (waiting) results in a large, significant, and consistent reduction in mortality.

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

Arthur J. Moss, M.D., Claudio Schuger, M.D., Christopher A. Beck, Ph.D., Mary W. Brown, M.S., David S. Cannom, M.D., James P. Daubert, M.D., N.A. Mark Estes III, M.D., Henry Greenberg, M.D., W. Jackson Hall, Ph.D.,* David T. Huang, M.D., Josef Kautzner, M.D., Ph.D., Helmut Klein, M.D., Scott McNitt, M.S., Brian Olshansky, M.D., Morio Shoda, M.D., David Wilber, M.D., and Wojciech Zareba, M.D., Ph.D., for the MADIT-RIT Trial Investigators†

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

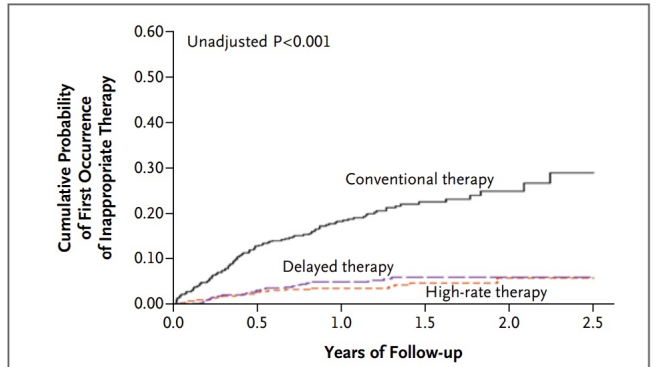


Figure 1. Cumulative Probability of First Occurrence of Inappropriate Therapy According to Treatment Group.

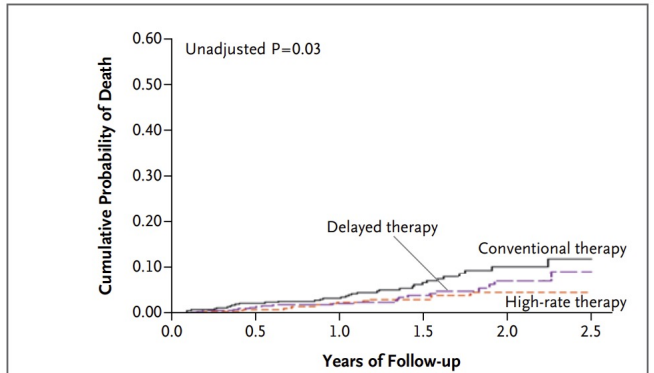
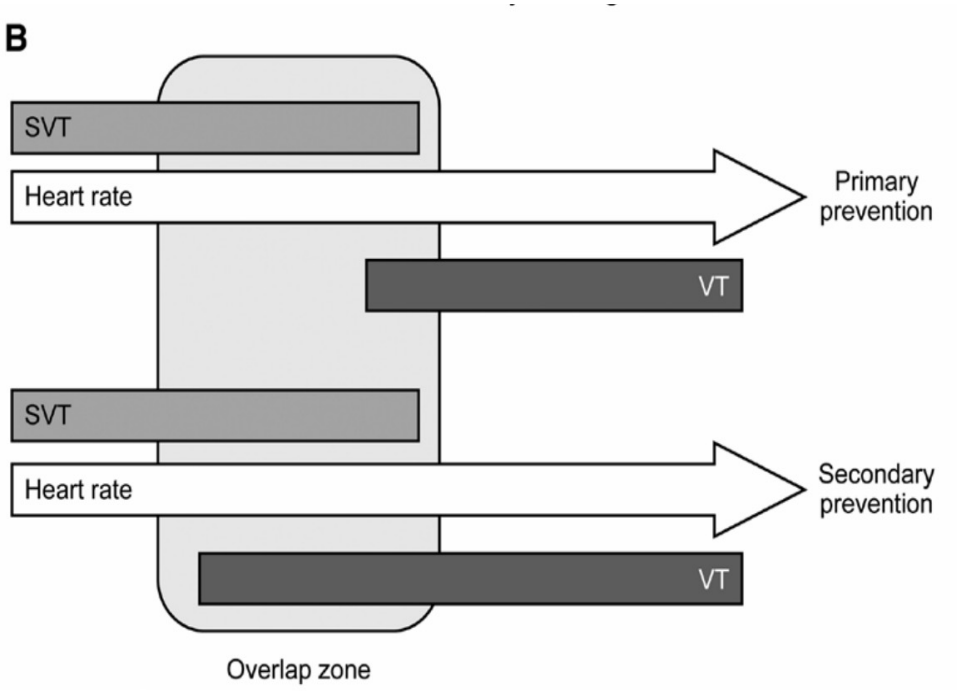


Figure 2. Cumulative Probability of Death According to Treatment Group.

- Supraventriküler ve ventriküler aritmilerin ventriküler hızları arasında bir örtüşme mevcut ve uygunsuz şokların çoğunluğunun 181 ila 213 bpm arasındaki hızlarda meydana gelmekte
- Tedavileri azaltmak için hızın 200 bpm'ye kadar çıkarmak güvenli
- MADIT-RIT çalışmasının sonuçları da desteklenmekte

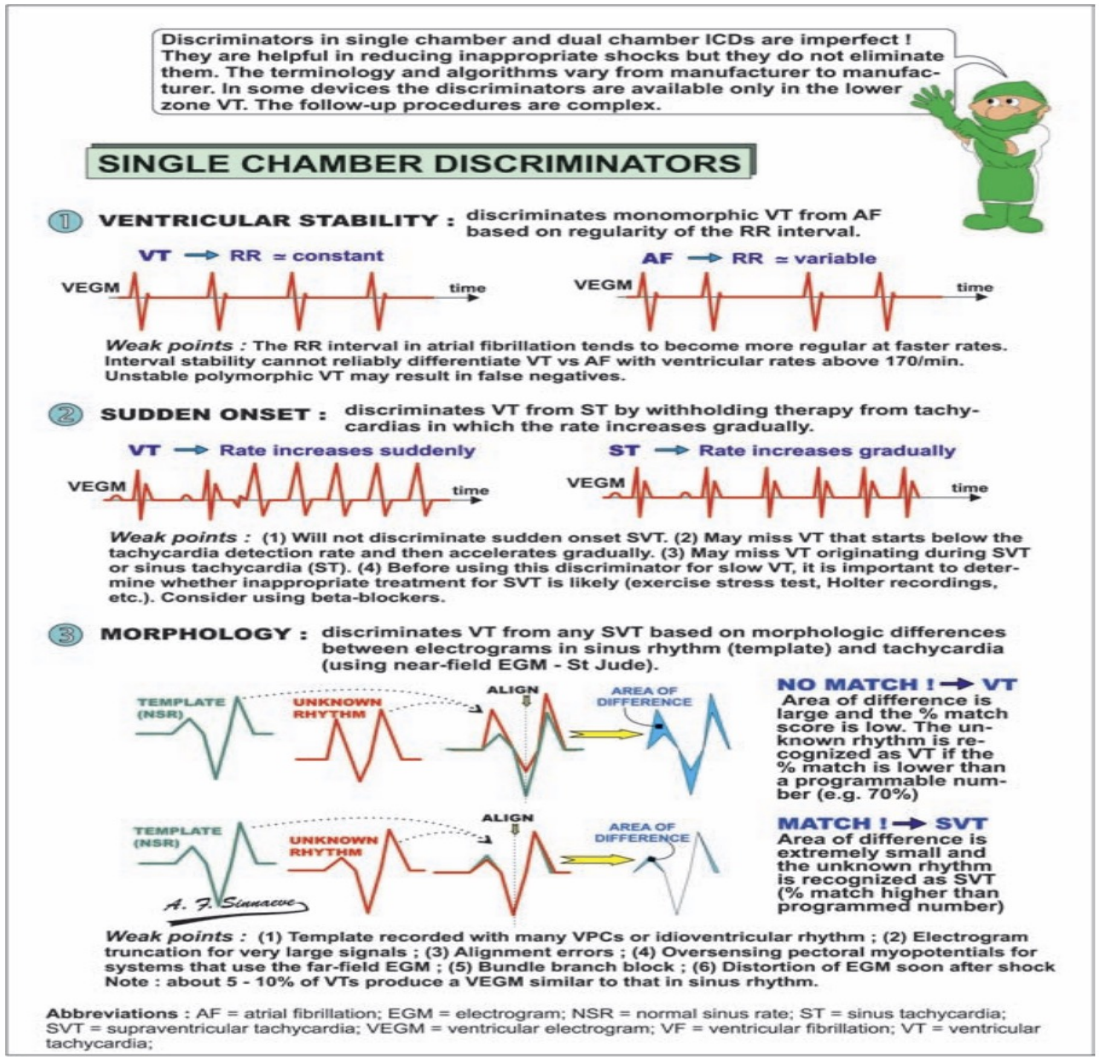


VT/VF Zonları

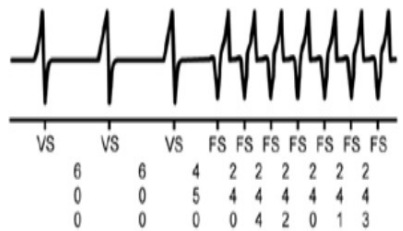
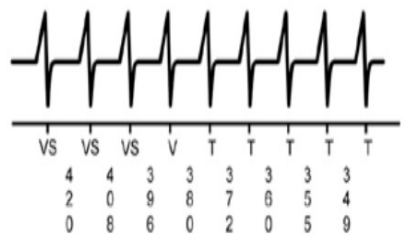
- ICD’ ler farklı ventriküler hız aralıklarında farklı algoritmalar kullanır.
- Bu farklı algoritmalar ; farklı tedavi seçeneklerine izin verir (daha yavaş ve hemodinamik daha stabil VT'ler için daha uzun bekleme ve daha fazla ATP sekansı…)
- Birden fazla taşikardi bölgesinin programlanması VT'yi SVT'den ayırmada daha fazla özgüllüğe olanak tanır.

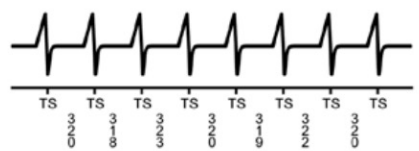
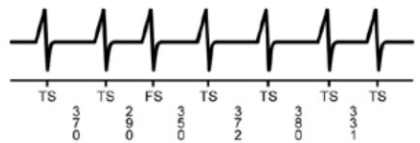
- ALTITUDE REDUCES çalışmasından elde edilen gözlemsel veriler, çift zon programlamanın tek zon programlamaya göre daha az şokla ilişkili olduğunu göstermektedir.

SVT-VT ayırıcı komponentleri



Ventriküler hız tek başına zorunlu bir ayırıcıdır.

Algorithm	Function	Strengths	Limitations	Performance	Suggested parameter settings
Onset Inhibit therapy if gradual onset *Rationale:* Sinus tachycardia has gradual onset compared to abrupt onset of VT	Abrupt onset of VT  Slow warm up of sinus tachycardia  	High sensitivity for distinguishing sinus tachycardia from VT	Misclassify • AF, SVTs with abrupt onset as VT • Exercise induced VT that follows sinus tachycardia under detected • PVCs before VT may misclassify VT as gradual onset • Applied only once at initial detection - misclassification cannot be corrected	• Accuracy in rejecting sinus tachycardia – 98% • VT under detection in 0.5%[24] • Specificity – 64%[19]	• Medtronic 84 – 88% • Boston Scientific 9% • St. Jude 100 ms

Algorithm	Function	Strengths	Limitations	Performance	Suggested parameter settings
Stability Inhibit therapy if ventricular rate is variable *Rationale:* RR intervals are irregular in AF compared to regular in VT	Stable RR intervals in VT  Irregular RR intervals in AF  	High sensitivity for discriminating VT from AF at rates < 170bpm	Misclassify • Stable SVT (e.g. atrial flutter) as VT • Rapid AF where RR is less variable as VT • Irregular VT (such as in the setting of anti-arrhythmic drugs) as AF	• Sensitivity 95%, specificity 77 – 88% at rate < 170bpm[19, 23] • Sensitivity and specificity ↓ at rates >170bpm. Best applied to tachycardia <170bpm[23]	• Medtronic 40 – 50 ms • Boston Scientific 24 – 40 ms, 2.5s • St. Jude 80 ms

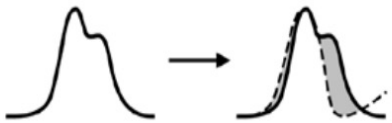
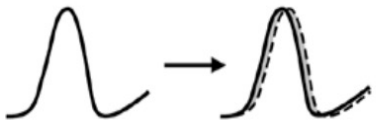
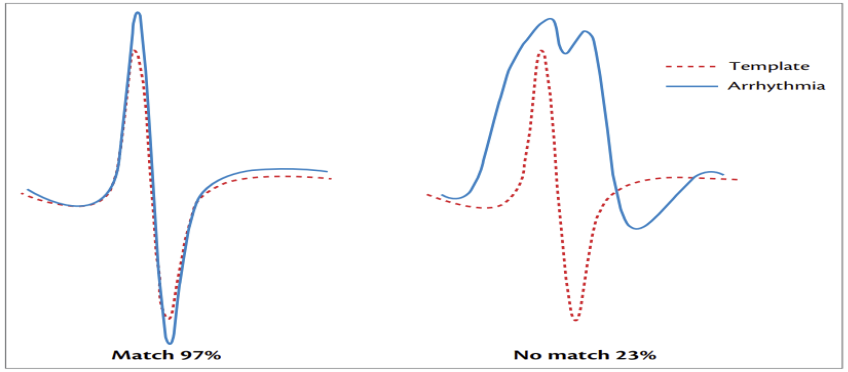
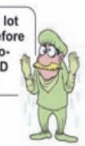
Algorithm	Function	Strengths	Limitations	Performance	Suggested parameter settings
Morphology Inhibit therapy if morphology of intracardiac electrogram matches template stored in normal rhythm *Rationale:* Discriminates SVT from VT based on comparison of morphology, independent of RR intervals	VT – morphology does not match template  SVT – morphology matches template 	• Discriminate abrupt onset stable SVT (e.g. atrial flutter) from VT • Applied continuously, permits correction if initial misclassification occurs • Can be applied at rapid rates > 200bpm	• Misclassify SVT with aberrancy • Misclassification due to electrogram mal-alignment, truncation • Cannot be applied to redetection post shock	• Most accurate of the single chamber algorithms • Medtronic wavelet™ sensitivity 100%, specificity 78%[26] • Boston Scientific Rhythm ID™ sensitivity 99-100%, specificity 92-97%[27, 28] • St. Jude Morphology Discrimination™ in conjunction with dual chamber discriminators sensitivity 100%, specificity 84%[29]	Medtronic - 3/8 electrograms >70% match Boston Scientific - Rhythm ID™ 'ON"* St. Jude - 5/8 electrograms > 60% match S-ICD: conditional zone 200-229 bpm (primary prevention)

Figure 41.4 Morphology discrimination algorithm

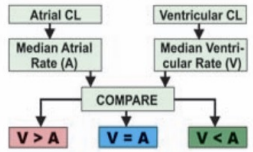


DISCRIMINATION ALGORITHMS
The St JUDE system - part 1

THE DUAL CHAMBER APPROACH

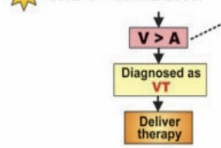


1 RATE BRANCH ALGORITHM



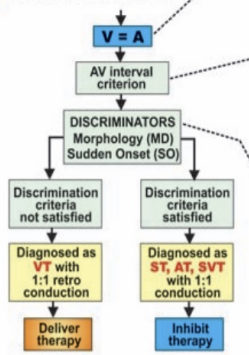
- The "Rate Branch" algorithm looks at the AA and VV intervals in a window at the time of detection.
- A and V rates are determined as the median of the AA (or VV) intervals in that window.

2 THE V > A BRANCH



- If the ventricular rate V exceeds the atrial rate the tachycardia is by definition classified as VF/VT !
- No discriminators are used in this branch.

3 THE V = A BRANCH



- In the "V = A rate branch" the AV interval criterion is used as a pre-qualifier.
- "AV interval" looks at the differences in AV intervals.
- A rhythm must be considered associated (i.e. AV conduction being stable) by the AV interval discriminator before it can be classified into the V =A branch. If the AV interval data (programmed via "AV interval delta") indicates AV dissociation, the morphology and sudden onset discriminators are not evaluated and the rhythm is immediately diagnosed as VT. This is useful in patients with double tachycardias (VT + SVT).

- Both discriminators, morphology discrimination (MD) and sudden onset (SO), may programmed ON or OFF
- Diagnosis settings can programmed ANY or ALL
  - * setting ANY : one satisfied discriminator (MD or SO) is sufficient to inhibit the therapy
  - * setting ALL : both discriminators (MD and SO) are to be satisfied to inhibit therapy
- Safest setting : MD = ON, SO = ON, criteria = ANY

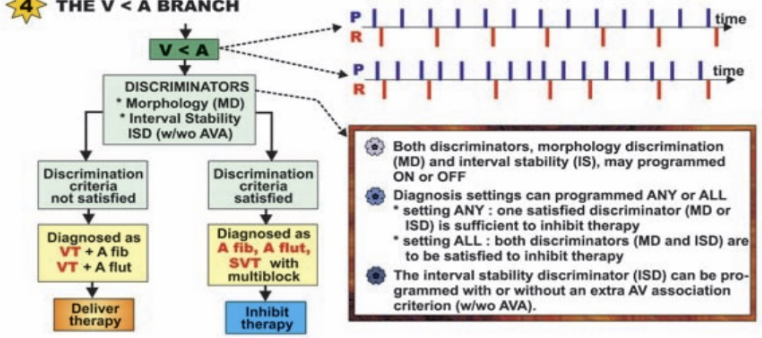
A. F. Sinnaeve

Abbreviations : *AT = atrial tachycardia; AV = atrioventricular; CL = cycle length; MD = morphology discrimination; SO = sudden onset discriminator; ST = sinus tachycardia; SVT = supraventricular tachycardia; VF = ventricular fibrillation; VT = ventricular tachycardia;*

DISCRIMINATION ALGORITHMS
The St JUDE system - part 2

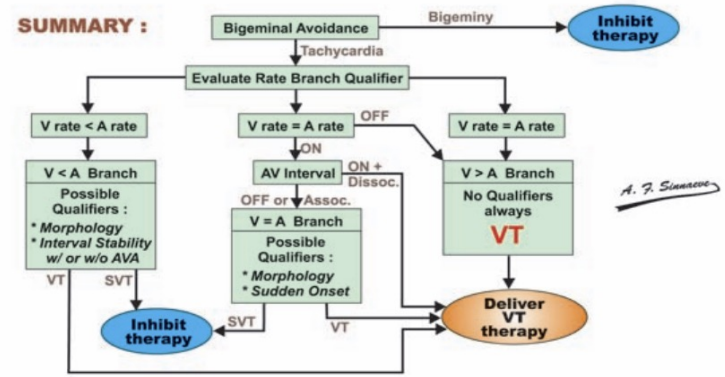
THE DUAL CHAMBER APPROACH

4 THE V < A BRANCH



- Both discriminators, morphology discrimination (MD) and interval stability (IS), may programmed ON or OFF
- Diagnosis settings can programmed ANY or ALL
  - * setting ANY : one satisfied discriminator (MD or ISD) is sufficient to inhibit therapy
  - * setting ALL : both discriminators (MD and ISD) are to be satisfied to inhibit therapy
- The interval stability discriminator (ISD) can be programmed with or without an extra AV association criterion (w/wo AVA).

SUMMARY :



A. F. Sinnaeve

NOTE :
A bigeminal rhythm may have average intervals shorter than the tachycardia detection interval. To prevent against delivering therapy in single Tach configuration or Tachy A configuration (slower tachycardia if 2 tachycardia rates are programmed), the ICD must detect more tachycardia intervals than sinus intervals before it delivers therapy !

Abbreviations : *A fib = atrial fibrillation; A flut = atrial flutter; AVA = AV association; SVT = supraventricular tachycardia; VT = ventricular tachycardia;*

Table 42.2 Differentiating VT from SVT on EGM tracings

VT	SVT
◆ Complete AV block ◆ V > A ◆ Very rapid (e g. >240bpm) and not artefacts ◆ EGM morphology very different (! aberration) ◆ Starts with V ◆ V–V irregularities precede A–A irregularities (! may also be seen with AVNRT) ◆ Ends with A (! may also be seen with AVNRT or AVRT) ◆ ATP is effective (! SVT that can be stopped by ATP: AVNRT, AVRT, AT if VA conduction; ! AF with post-ATP pause)	◆ Gradual onset (! VT induced by exercise) ◆ Irregular rhythm (! some VTs may be irregular) ◆ Starts with A ◆ EGM is *identical* to normal rhythm (use all EGMs, also 'can–RV coil'; ! EGM may change after shock) ◆ A–A irregularities *precede* V–V irregularities ◆ 'VAAV' sequence after ineffective ventricular ATP and atrial reset (→ AT/atypical AVNRT)

AT, atrial tachycardia; AF, atrial fibrillation; ATP, antitachycardia pacing; AVNRT, atrioventricular nodal re-entrant tachycardia; AVRT, atrioventricular re-entrant tachycardia; EGM, electrogram; caveats are indicated by '!'.

Tachycardia therapy programming recommendations	Class of recommendation	Level of evidence
It is recommended in all patients with structural heart disease and ATP-capable ICD therapy devices that ATP therapy be active for all ventricular tachyarrhythmia detection zones to include arrhythmias up to 230 bpm, to reduce total shocks except when ATP is documented to be ineffective or proarrhythmic.	I	A
It is recommended in all patients with structural heart disease and ATP-capable ICD therapy devices that ATP therapy be programmed to deliver at least 1 ATP attempt with a minimum of 8 stimuli and a cycle length of 84–88% of the tachycardia cycle length for ventricular tachyarrhythmias to reduce total shocks, except when ATP is documented to be ineffective or proarrhythmic.	I	A
It is indicated to programme burst ATP therapy in preference to ramp ATP therapy, to improve the termination rate of treated ventricular tachyarrhythmias.	I	B-R
It is reasonable to activate shock therapy to be available in all* ventricular tachyarrhythmia therapy zones, to improve the termination rate of ventricular tachyarrhythmias. **Rarely, to limit patient discomfort and anxiety, haemodynamically stable slow VT can be treated without programming a backup shock.*	IIa	C-EO
It is reasonable to programme the initial shock energy to the maximum available energy in the highest rate detection zone to improve the first shock termination of ventricular arrhythmias unless specific defibrillation testing (DT) demonstrates efficacy at lower energies.	IIa	C-LD

- Uygun ve uygunsuz ICD şokları ölüm riskinde önemli bir artışla ilişkilendirilmiştir.
- SCD-HeFT çalışmasında, uygun ICD şoku alan hastalarda mortalite riski beş kat, uygunsuz şok alan hastalarda ise iki kat daha yüksek bulunmuştur.
- Mevcut veriler, başarısız ATP'den sonra başarı oranının daha düşük olduğunu gösterdi. Bu nedenle ,ATP'den sonra daha yüksek bir enerji seviyesinin programlanmasını önermektedir.

ATP rutin programlanmama

- Kanolopatiler(Brugada S. , long ve short QT S.)
- CPVT
- Erken repolarizasyon sendromları
- Polimorfik VT ve VF

Medtronic

Brady	Single Chamber VVI 40bpm Dual Chamber DDD, consider Managed Ventricular Pacing (MVP; AAI↔DDD) ± rate response CRT DDD ± rate response Patient with intact AV conduction and LBBB—Consider Adaptive BiV & LV*
Detection	In patients with no VT history VF: 30/40 intervals, 188bpm FVT: OFF[1] VT: OFF VT Monitor: User discretion In patients where VT CL is known VF: 30/40 intervals, 188bpm FVT: OFF[1] VT: 24* intervals[2], 10–20bpm < VT rate VT Monitor: User discretion
Therapy	VF: ATP Before* Charging; ChargeSaver ON All shocks: Full output shocks (unless DFT guided) VT (if ON): Rx1: ATP, ≥1 bursts of 8 pulses at 88% VT CL, 10ms Decrement Rx2-6: All Shocks ON[3]
SVT Discriminators[4]	Single Chamber Wavelet: ON Limit: 260ms (230bpm) Stability: OFF Onset: OFF Dual Chamber/CRT-D PR Logic: ON (Other 1:1 OFF until lead stabilized at ~3 months) Wavelet: ON (if available) SVT Limit: 260ms (230bpm) Stability: OFF Onset: OFF
Oversensing Rejection	Lead Integrity Alert: ON T-wave Oversensing: ON (if available) RV Lead Noise: ON* without timeout (if available)

Settings that are not nominal are marked with an asterisk.
[1]Use of ATP Before/During Charging in the VF zone achieves similar functionality as use of the FVT zone. Multi-zone programming using FVT may allow tiered ATP therapy.
[2]Consecutive count in VT zone; hence, lower NID as per PainFree SST data.
[3]Rarely, hemodynamically stable slow VT can be treated without programming a back-up shock.
[4]SVT Discriminators are not required in Complete Heart Block.

Boston Scientific

Brady	Single Chamber
	VVI, 40bpm*
	Dual Chamber
	DDD, consider RYTHMIQ* or AV Search +* ± rate response
	CRT
	DDD ± rate response
	Consider Smart Delay optimization of AV delays
Detection	In patients with no VT history
	Option 1 – delayed therapy
	VF: 8 of 10 intervals plus 5-second duration*, 250bpm*
	VT: 8 of 10 intervals plus 12-second duration*, 185bpm*
	VT-1: Monitor, at user discretion
	Option 2 – high-rate therapy
	VF: 8 of 10 intervals plus 2.5-second duration*, 200bpm*
	VT-1: Monitor, at user discretion
	In patients where VT cycle length is known
	VF: 5-second duration*, 250bpm*
	VT: 12-second duration*, 185bpm* or 10–20bpm < VT rate
	VT-1: Monitor Zone or Therapy at ≥12-second duration*, 10–20bpm < VT rate
Therapy	VF: QuickConvert ON to 300bpm* (if available)
	All shocks: Maximum output (unless DFT guided)
	VT: ATP-1: Scan, ≥1 bursts, 8 pulses* at 84%* coupling interval and cycle length (Minimum 200ms*), 10ms decrement*
	ATP-2: OFF*
	All shocks: ON
	VT-1: As for VT, favoring more ATP[1]
SVT Discriminators[2]	ICD
	RhythmID: ON
	CRT-D
	Onset/Stability: ON *or* RhythmID: ON*
	Sustained Rate Duration (SRD): OFF*
	SVT Discriminators apply only up to 230bpm
Oversensing Rejection	Nonphysiological Signal Detected: ON (Latitude)
Others	Turn on "Beep When Out-of-Range" Daily Lead Measurements*
	RV Pacing Impedance Abrupt Change alert ON (Latitude)
	Single Chamber: Consider %RV pacing alert ON (Latitude)
	Dual Chamber: Consider %RV pacing alert in non-AVB patients ON (Latitude)
	CRT-D: Consider CRT % pacing alert ON (Latitude)
SUBCUTANEOUS ICD	
Settings:	Shock Zone: ≥230bpm
	Conditional Zone: ≥200bpm or 10–20bpm < VT CL (if known)
	Consider post-shock pacing ON

**Settings that are not nominal are marked with an asterisk.*
[1]Rarely, hemodynamically stable slow VT can be treated without programming a back-up shock.
[2]SVT Discriminators are not required in Complete Heart Block.

Abbott (Formerly St. Jude Medical)

Brady	Single Chamber VVI 40bpm Dual Chamber DDD, consider Ventricular Intrinsic Preference (VIP) ± rate response CRT DDD ± rate response Consider SyncAV* (if intact AV conduction) as appropriate
Detection	In patients with no VT history VF: 30 intervals*[1], 240 or 250bpm* VT2: 30 intervals*[1], 187bpm* VT: Monitor, at user discretion In patients where VT CL is known VF: 30 intervals*[1], 240 or 250bpm VT2: 30 intervals*[1], 187bpm or 10–20bpm < VT rate* VT: Therapy at 10–20bpm < VT rate or Monitor zone
Therapy	VF: ATP While Charging, 8 pulses at 85% VT CL All shocks: Maximum output (unless DFT guided) Note: 1st shock 4–6J lower than full output VT2: ATP, ≥1 bursts of 8 pulses at 85% VT CL Scan step 10ms, Re-adaptive ON, Minimum CL 200ms All shocks ON VT: As for VT2, favoring more ATP[2]
SVT Discriminators[3]	Single Chamber Far-Field Morphology: ON, 90%, 3 of 10 All others: "Passive" Dual Chamber/CRT-D Far-Field Morphology: ON, 90%, 3 of 10 Arrhythmia onset: ON (default settings) Interval Stability: ON (default settings) If ALL For CRT: Template Auto Update 30 days and Template Pacing Hysteresis ON *or* Far-Field Morphology Auto Update OFF SVT Upper Limit: 230bpm SVT Discrimination Timeout: OFF VT Therapy Timeout: OFF
Oversensing Rejection	Low Frequency Attenuation: ON SecureSense RV Lead Noise Discrimination: ON

Settings that are not nominal are marked with an asterisk.

[1]Fewer intervals to detect may be reasonable due to the possibility of VT straddling 2 zones that may result in "binning" to both zones, effectively doubling time to detect. Beats that fall out of zone sometimes reset counters so patients with poor sensing should also have fewer detection intervals considered.

[2]Rarely, hemodynamically stable slow VT can be treated without programming a back-up shock.

[3]SVT Discriminators are not required in Complete Heart Block.

BIOTRONIK

Brady	Single Chamber	
	VVI 40bpm	
	Dual Chamber	
	DDD, consider IRS Plus*/I OPT* ± Closed Loop Stimulation (CLS)* *or*	
	DDD with Vp Suppression* ± rate response	
	CRT	
	DDD; optional DDD-CLS* *or* rate response* at user discretion	
Detection	In patients with no VT history[1]	
	VF:	30/40 intervals* (if programmable, otherwise 24/30), 231bpm*
	VT2:	30 intervals*, 188bpm*
	VT1:	Monitor zone* at user discretion
	In patients where VT CL is known	
	VF	24/30 intervals*, 231bpm*
	VT2:	30 intervals*, 188bpm* (or 10–20bpm < VT rate)
	VT1:	Therapy* at 10–20bpm < VT rate or Monitor zone* at user discretion
Therapy	VF:	ATP One-Shot, 1 burst of 8 pulses at 88%[2] CL*, full output shocks (unless DFT guided)
	VT2:	ATP ≥1 bursts* of 8 pulses* at 88%[2] CL*, 10ms scan decrement*, All shocks ON
	VT1:	Monitor zone* or Therapy* as for VT2 (favoring more ATP)[3]
SVT Discriminators[4]	Single Chamber	
	MorphMatch[5]	ON(*)
	Onset[6]	OFF
	Stability	OFF*
	Sustained VT Timer	OFF
	Dual Chamber/CRT-D	
	SMART	ON (at default settings or adapted to known VT)
Others	Lead Integrity check	ON (if available)
	HomeMonitoring	ON* (if available)

**Settings that are not nominal are marked with an asterisk.*

[1]SVT discriminators are linked to Detection Zones. An alternative configuration would be VF 250bpm, VT2 231bpm and VT1 188bpm with therapy (i.e., no Monitor zone) if >1 ATP attempt desired up to 250bpm.

[2]If programmable, otherwise 85%.

[3]Rarely, hemodynamically stable slow VT can be treated without programming a back-up shock.

[4]SVT Discriminators are not required in Complete Heart Block.

[5]MorphMatch is recommended for patients with narrow QRS complexes and sufficient far-field amplitude. Otherwise, Onset 20% and Stability 48ms is a recommended alternative.

[6]If Onset is programmed ON, the performance of this discriminator is enhanced with a Monitoring Zone enabled.

Teşekkürler.....