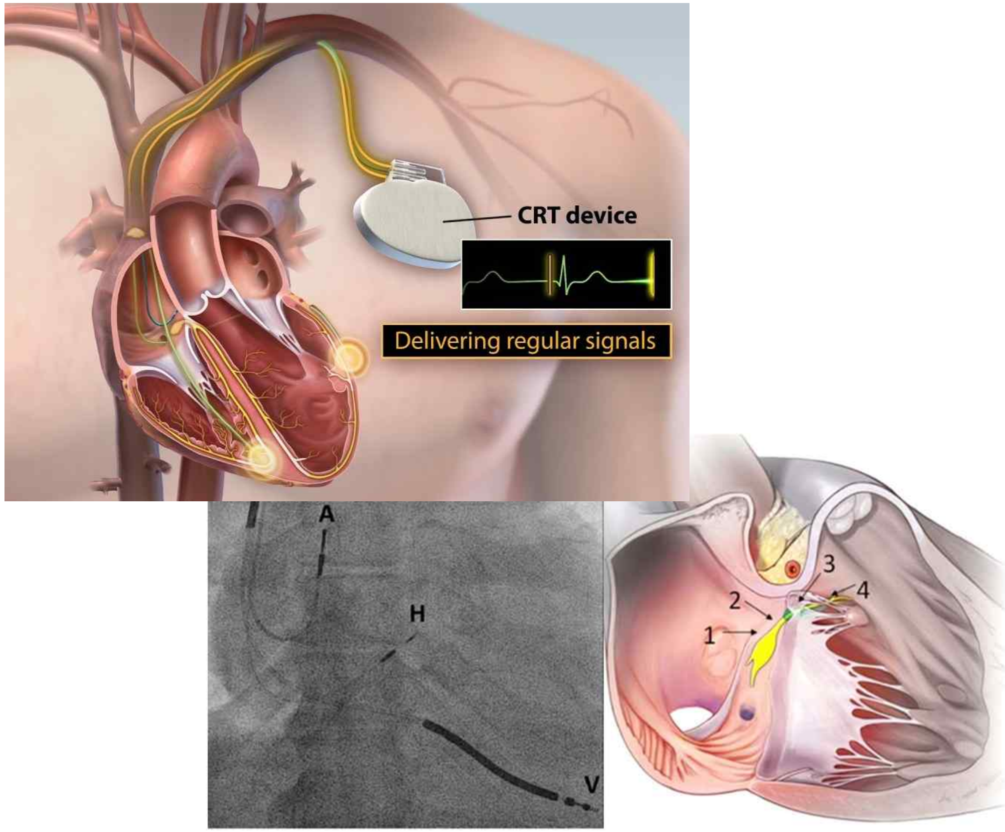
HBP vs. CRT for Patients with LV Dysfunction & LBBB

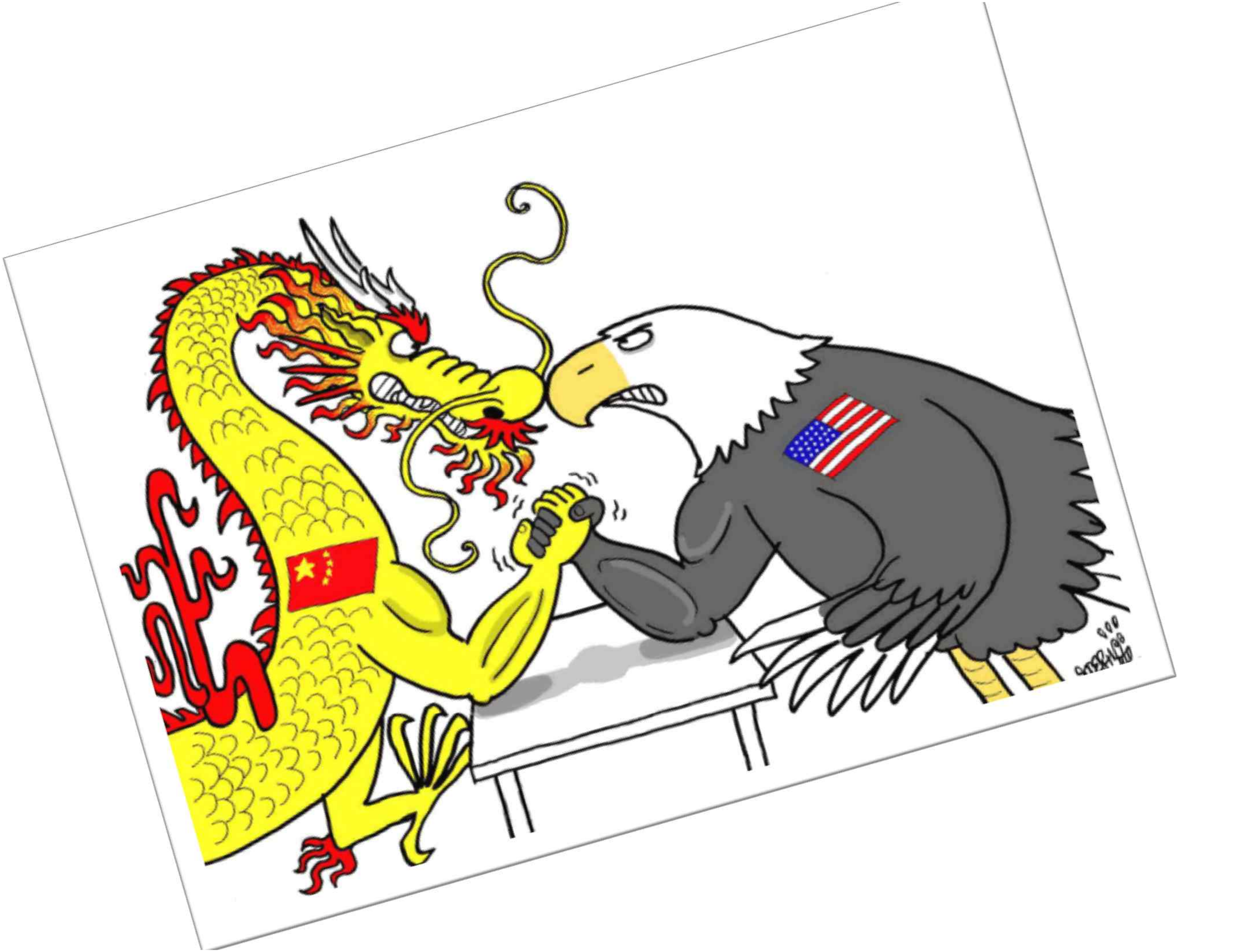
-CRT is still the Gold Standard-



Sungkyunkwan University School of Medicine

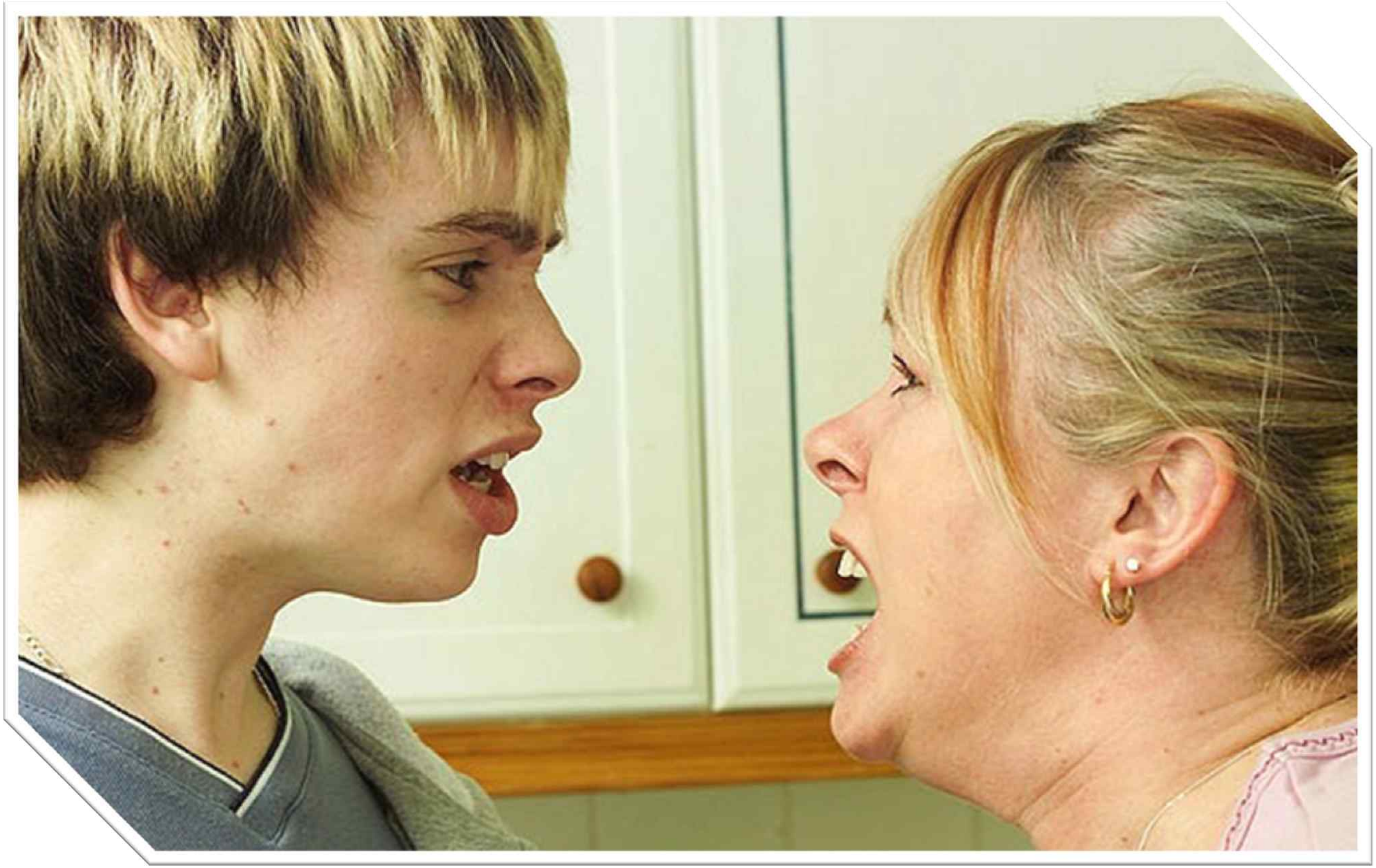
Samsung Medical Center Arrhythmia Center

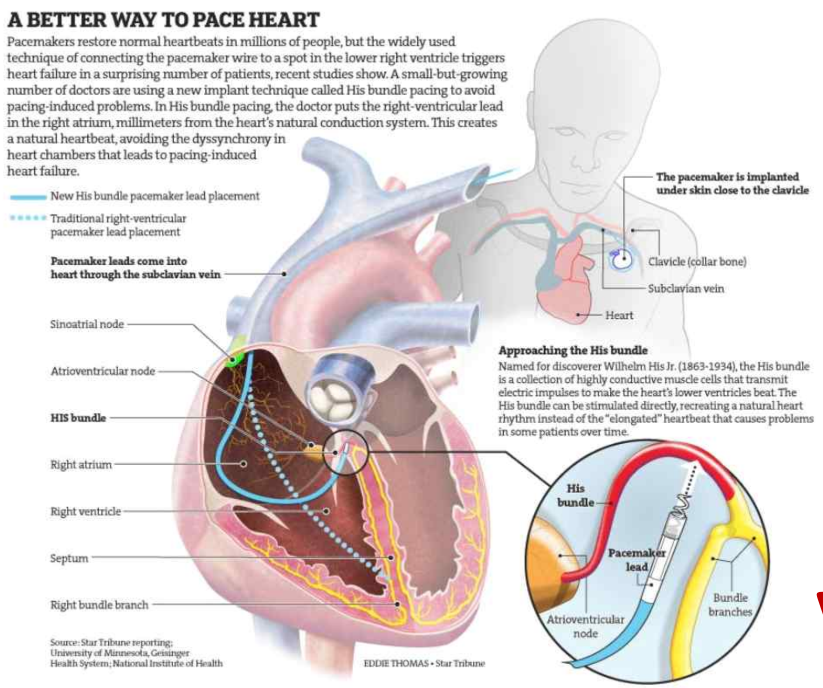
Seung-Jung Park




새누리당
새정치민주연합
제주일보


CLASH of CLANS

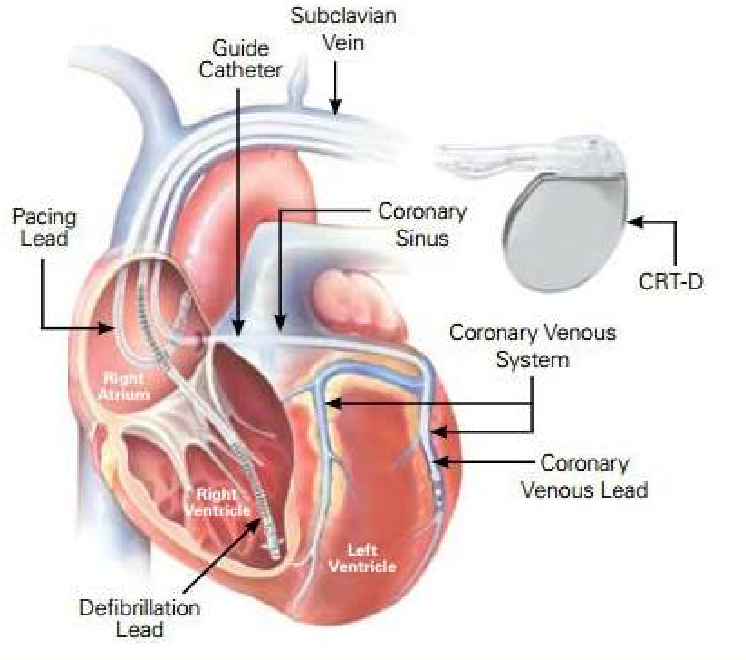




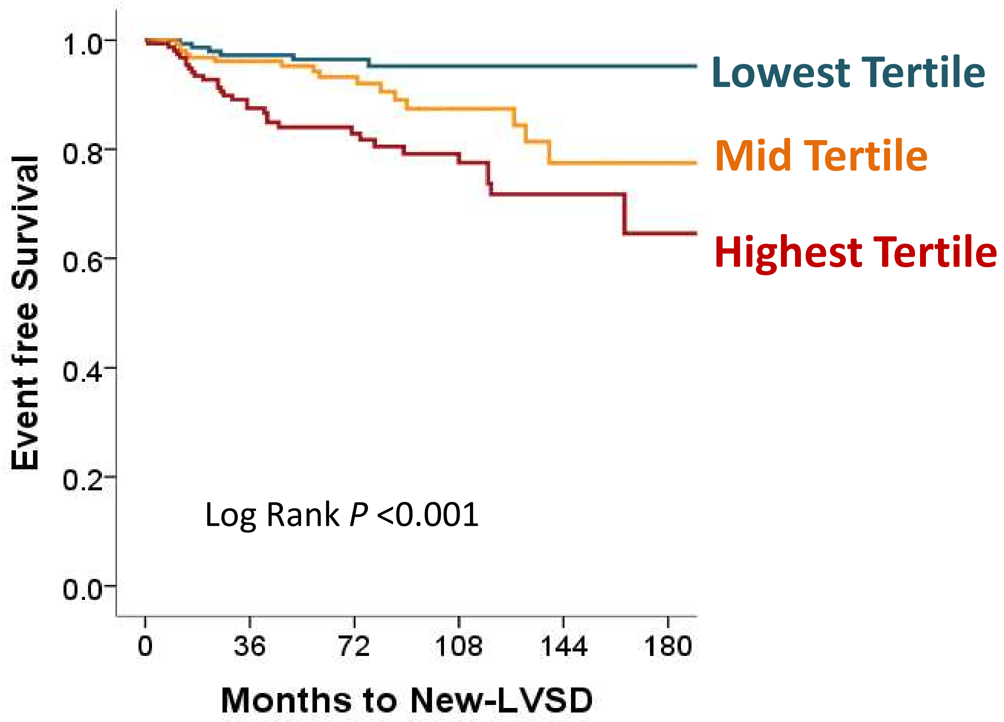
His-Bundle Pacing is a reasonable alternative to CRT

VS.

CRT is still the Gold Standard



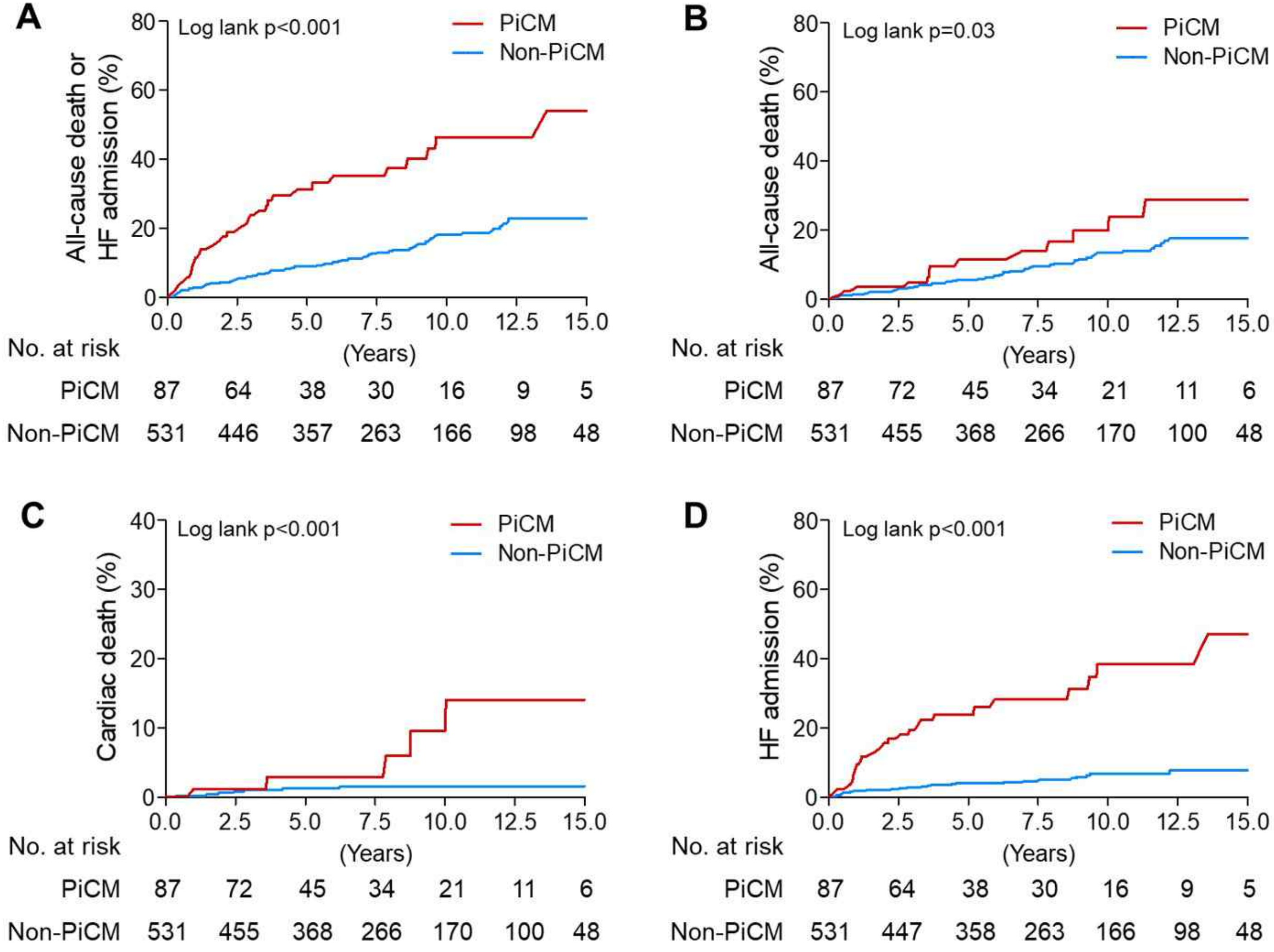
Chronic RV pacing & New-onset LV systolic dysfunction



No. at risks							No. of events
Lowest	160	130	84	51	23	5	*6*
Mid	166	118	78	39	16	5	*16*
Highest	165	106	71	49	22	4	*31*

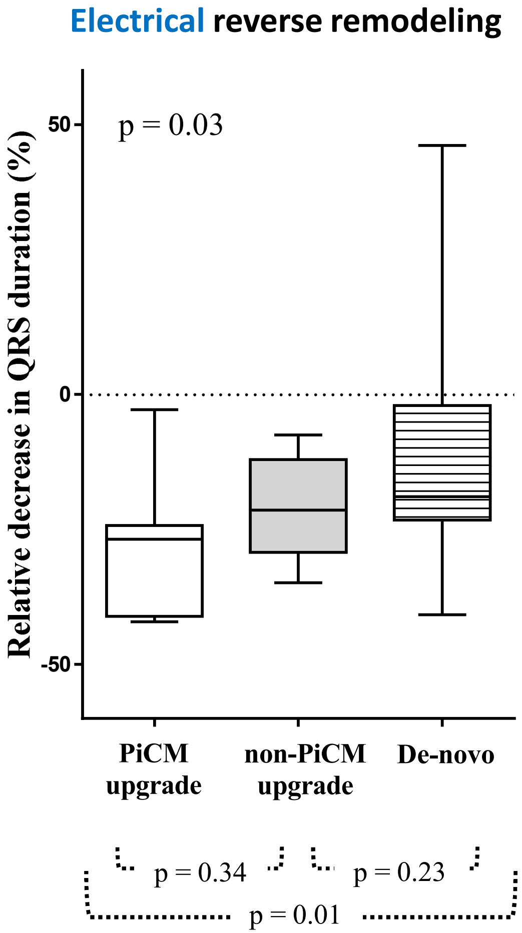
Cho EJ, Park SJ et al. Int J Cardiol. 2015

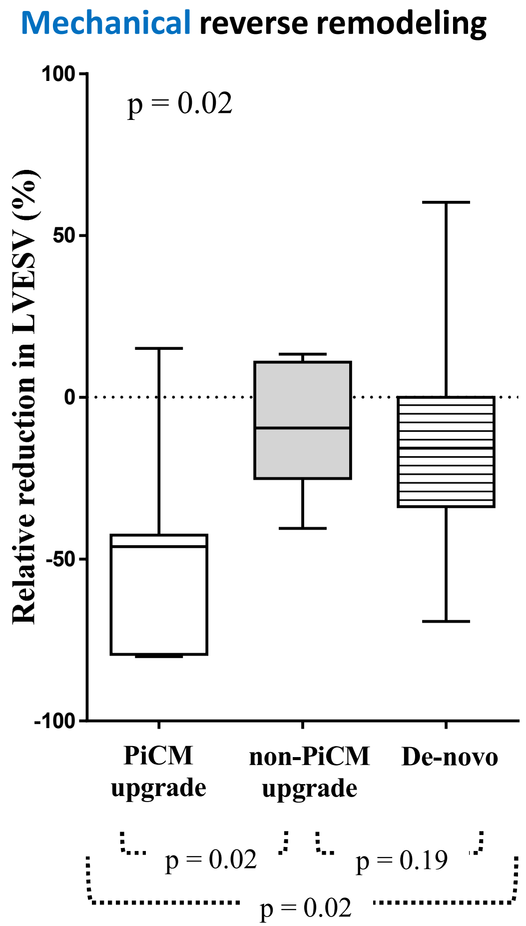
Worse outcomes of chronic RV-pacing



Cho SW, Park SJ et al. Eur J Heart Fail. 2019

CRT upgrade for PiCM



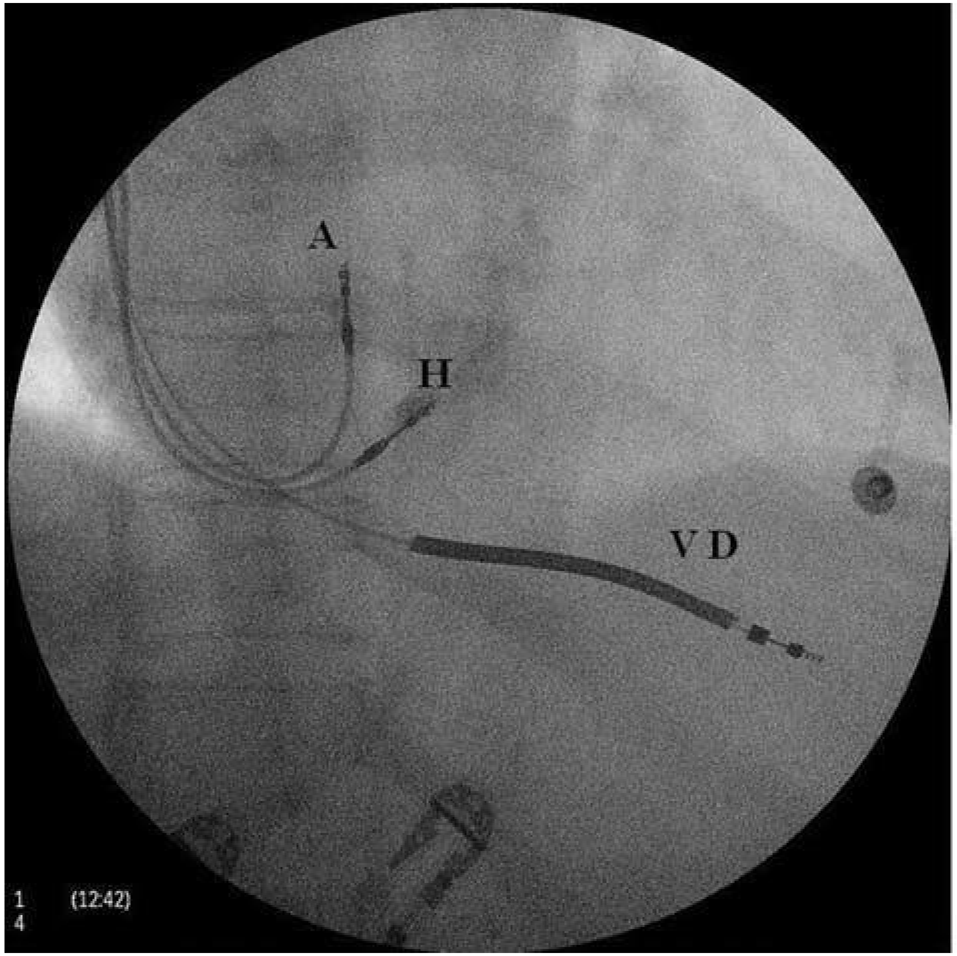


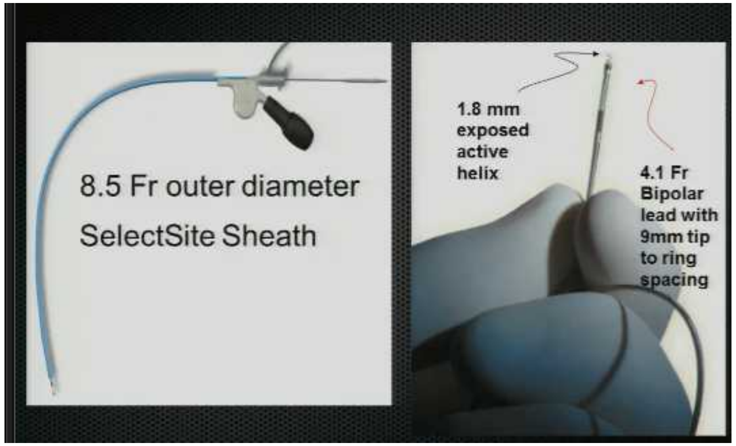
Absolute change = *Pre-CRT – post-CRT*

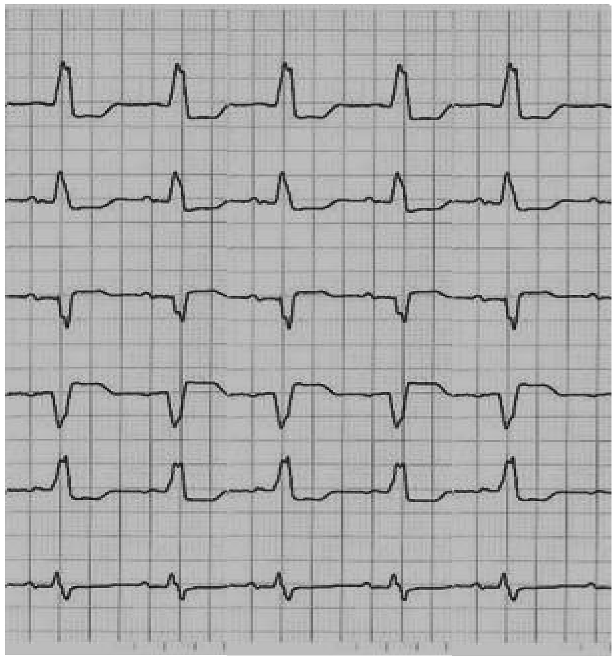
Relative change = $\frac{pre-CRT - post-CRT}{pre-CRT}$

HB Gwag, SJ Park, et al. Yonsei Med J 2017 Jul;58(4):703-709

Direct His Bundle Pacing







Europace (2010) 12, 527–533

Advantages of CRT over HBP

- **Implantation success rate**
  ; particularly in anomalous structure or valve disease
- **Stability of the Lead**
- **Concern for disease progression of conduction system**
- **Availability of defibrillator**
- **Automated optimization algorithm**
- **More data: more patients for longer duration**

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Highlights from
Heart Rhythm Society Scientific Sessions

His-SYNC: His bundle pacing not superior to biventricular pacing in cardiac resynchronization therapy

May 9, 2019

ADD TOPIC TO EMAIL ALERTS

SAN FRANCISCO — His bundle pacing as first-line therapy did not improve ECG or echocardiographic parameters compared with biventricular pacing in patients with HF requiring cardiac resynchronization therapy, according to the His-SYNC trial presented at the Heart Rhythm Society Annual Scientific Sessions.

The researchers conducted an investigator-initiated randomized pilot trial to compare His bundle pacing as a first-line strategy with biventricular pacing in 41 patients (mean age, 64 years; 38% women; mean left ventricular ejection fraction, 28%; mean QRS width, 168 ms) with HF meeting guideline recommendations for CRT.

Crossover rate: HBP → BiV pacing (48%) vs. **BiV pacing → HBP (26%)**

No superiority of HBP over BiV pacing (In the intention-to-treat analysis) regarding QRS narrowing, 6-month LVEF improvement, and12-month mortality/hospitalization.

Heart Rhythm. 2019. pii: S1547-5271(19)30440-0.

Failure rate of HBP

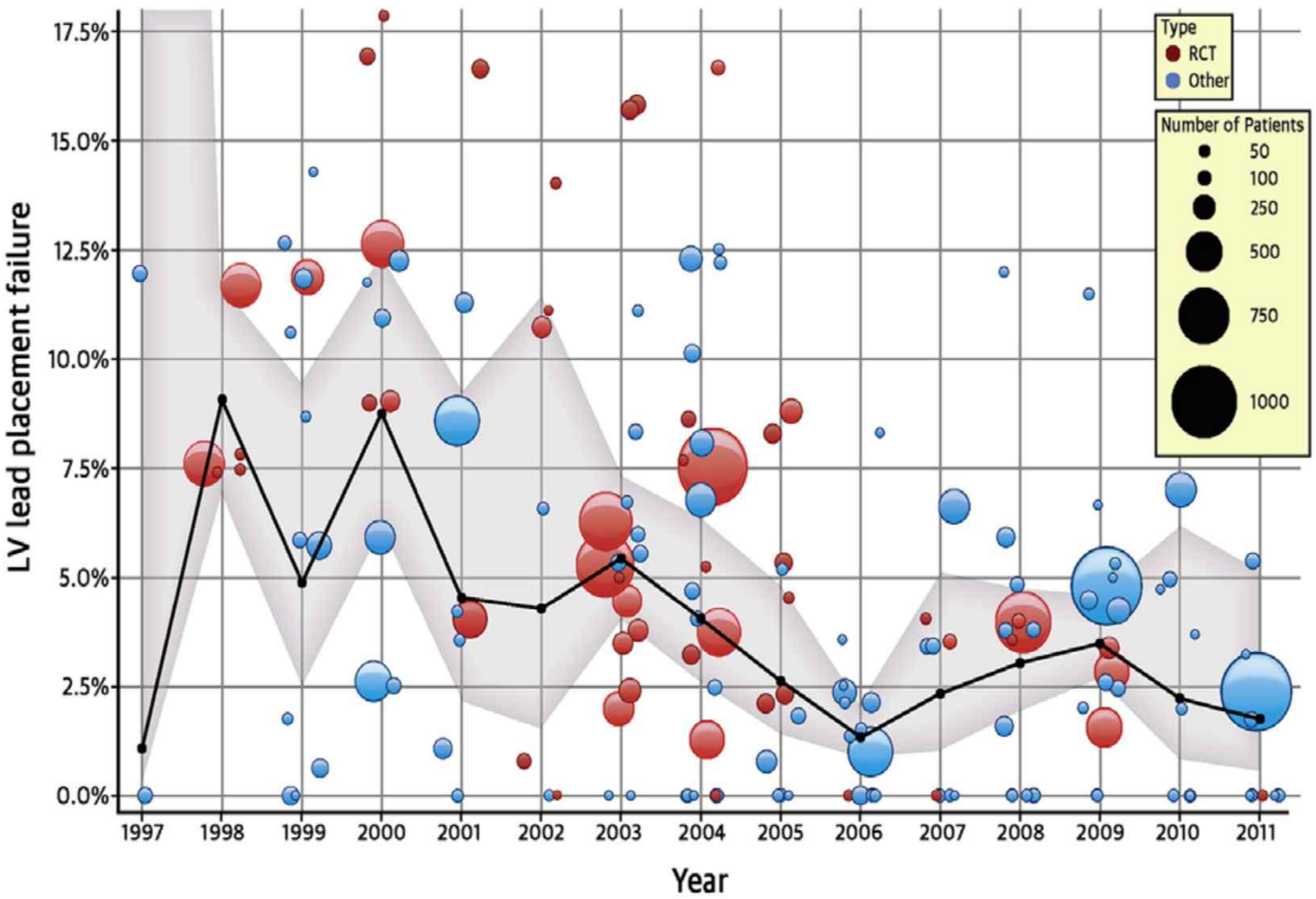
Study	Number of Patients, n	Overall Reported Technical Success Rate, n (%)	Reported Selective HBP Rate, n (%)	Threshold at Time of Implant, V (0.5 ms Pulse)	Distribution of Heart Failure Within Study Population	Notes
Cantu et al 2006[26]	17	17 (100)	11 (65)	1.7±1.2 (selective) 3.1±1.6 (nonselective)	5 (29%) had EF <40%	All patients had suprahisian block
Catanzariti et al 2006[28]	24	23 (96)	17 (74)	1.61±0.55	13 (56%) reported to have heart disease	All patients had suprahisian block
Zanon et al 2006[50]	26	26 (100)	24 (92)	2.3±1.0	26 (100%) reported to have cardiomyopathy	All patients had preserved His-bundle conduction
Lustgarten et al 2010[53]	10	10 (100)	10 (100)			...ad conventional ...ions
Kronborg et al 2011[41]	38	32 (84)	4 (13)			...ad suprahisian block
Zanon et al 2011[54]	307	Not known	87 (28)			...ad suprahisian block
Lustgarten et al (2015)[45]	29	17 (59) achieved permanent HBP with QRS narrowing				...97%) had left bundle ...k
Sharma et al 2015[37]	94	75 (80)	34 (45)	1.35±0.9	24 (32%) reported to have heart failure	44 (59%) had atrioventricular conducting system disease
Vijayaraman et al 2015[44]	100	84 (84)	22 (26)	1.4±1 V	Mean ejection fraction 54±10%	46 patients had atrioventricular nodal block, 54 patients had infranodal atrioventricular block
Ajijola et al 2017[46]	21	16 (76)	1 (6)	1.9±1.2 V at 0.6±0.2 ms	20 (95%) reported to have EF <35%	All patients reported to have an indication for CRT
Huang et al 2017[52]	52	42 (81)	38 (90)	1.5±1	42 (100%) reported to have heart failure	All patients had AF and underwent atrioventricular node ablation
Sharma et al 2018[47]	106	95 (90)	47 (50)	1.4±0.9 at 1 ms (His bundle capture) 2±1.2 at 1 ms (narrowing of BBB)	106 (100%) reported to have cardiomyopathy (LVEF 30±10% at baseline)	All patients had a CRT indication
Abdelrahman et al 2018[39]	332	304 (92)	115 (38)	1.30±0.85 at 0.79±0.26 ms	85 (26%) reported to have heart failure	Includes patients with wide range of pacemaker indications

Success rate 59~100%

Failure ~20%

AF indicates atrial fibrillation; BBB, bundle branch block; CRT, cardiac resynchronization therapy; EF, ejection fraction; HBP, His bundle pacing; LVEF, left ventricular ejection fraction.

Failure rate of CRT



J Am Coll Cardiol EP 2016;2:69–77

Procedural complexity of HBP

- Procedure time (70.2 ±34 minutes)
- Capture threshold (1.30±0.85V at 0.79±0.26ms)
- Early lead revision (4.2%)

- **Concerns for subsequent development of low infra-Hisian block remain.**

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  of conduction system
- **Availability of defibrillator**
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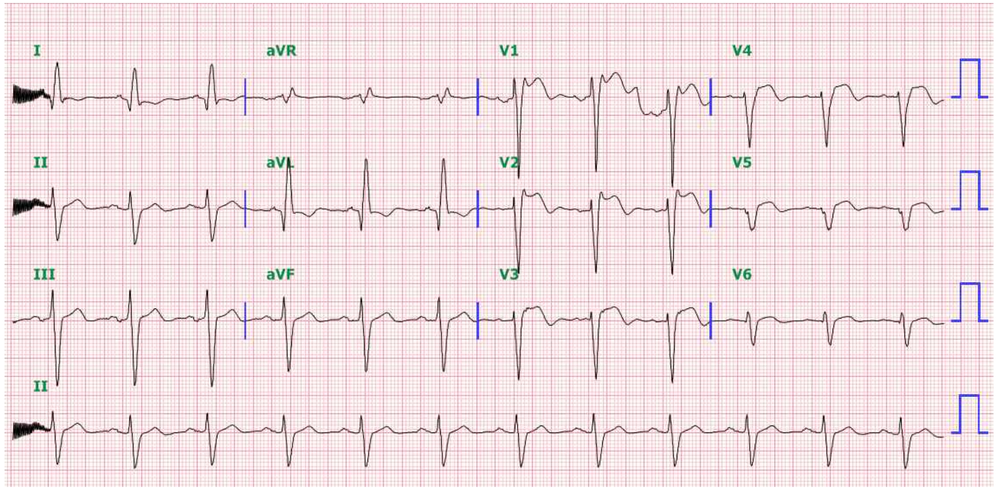
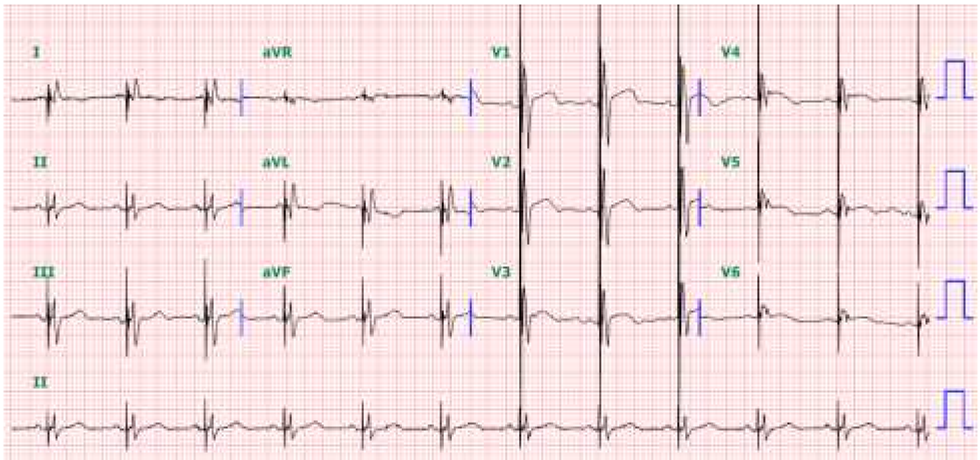
- More data: more patients for longer duration

M/60, ICMP

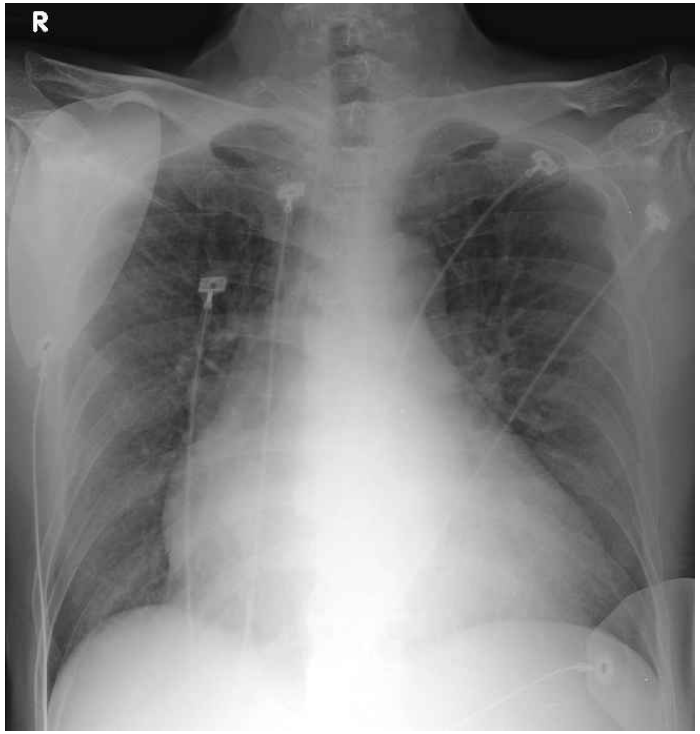
- 1984 AMI
- 2010 Echo: ICMP with severe LV systolic dysfunction(LVEF = 19%)
- 2014. 07 CRT-ICD implantation

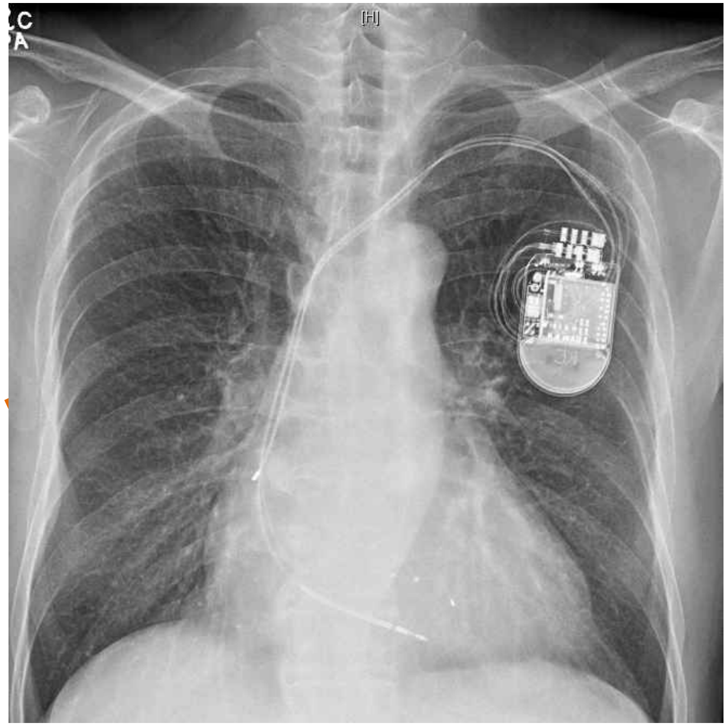
Wide QRS & CRT-D





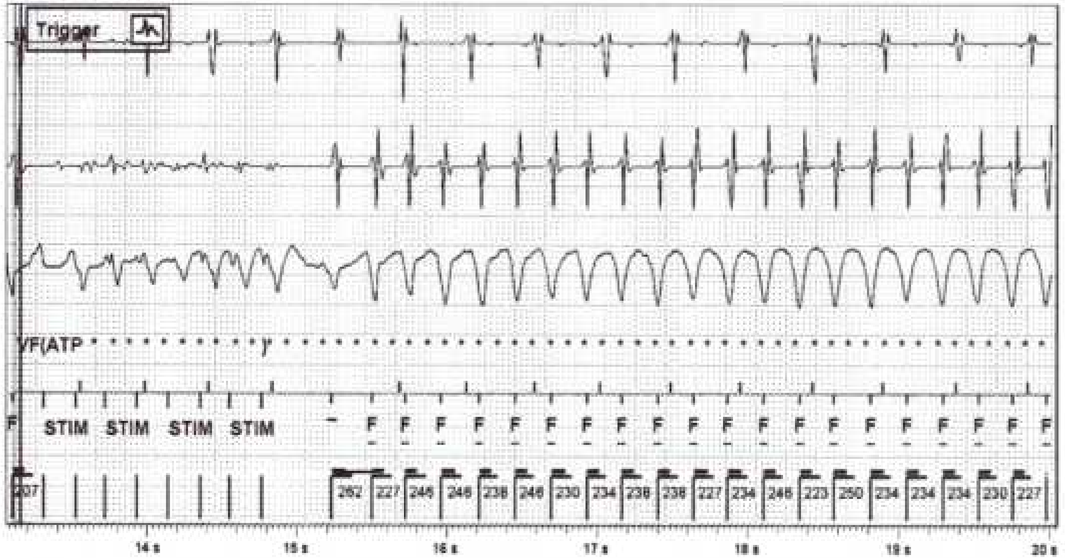
ICMP





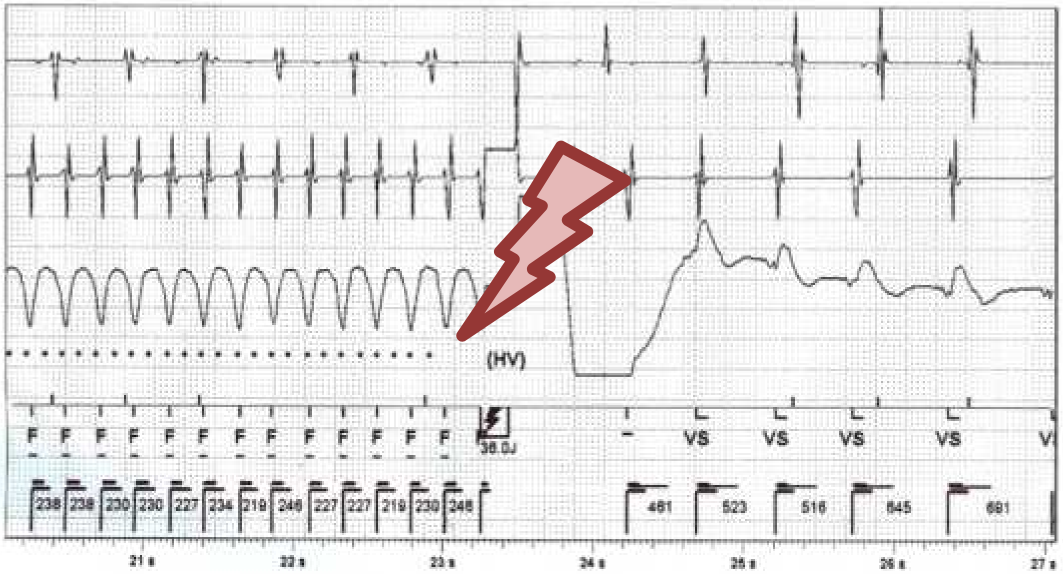
Episode: VF (244 min^{-1} / 245 ms) (Continued)

9 Jan 2015 18:16



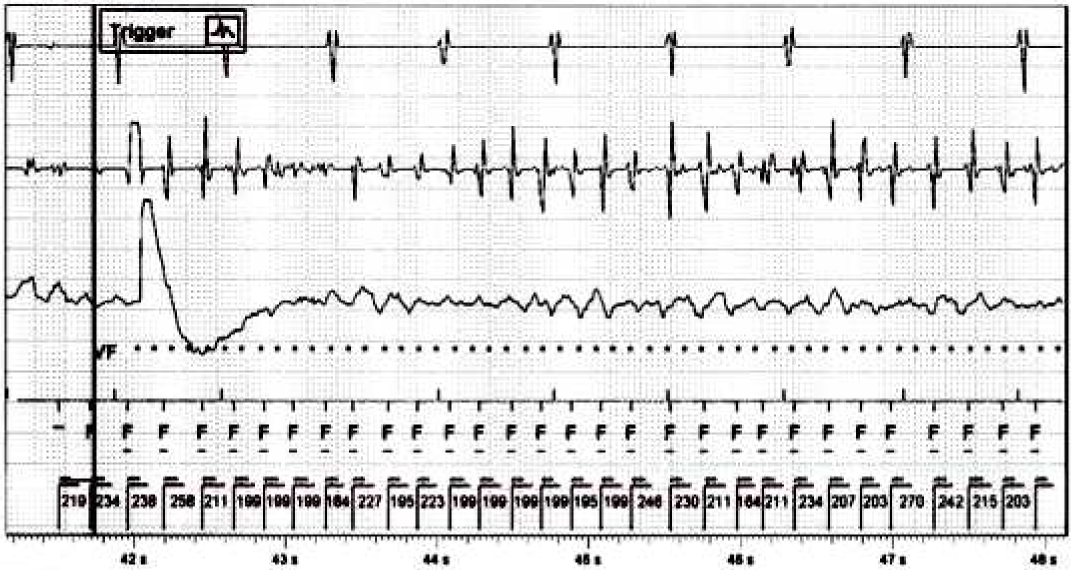
1: A Sense Amp AutoGain (2.8 mm/mV)
2: V Sense Amp AutoGain (0.6 mm/mV)
3: Discrimination AutoGain (1.5 mm/mV)
4: Markers

Sweep Speed: 25 mm/s



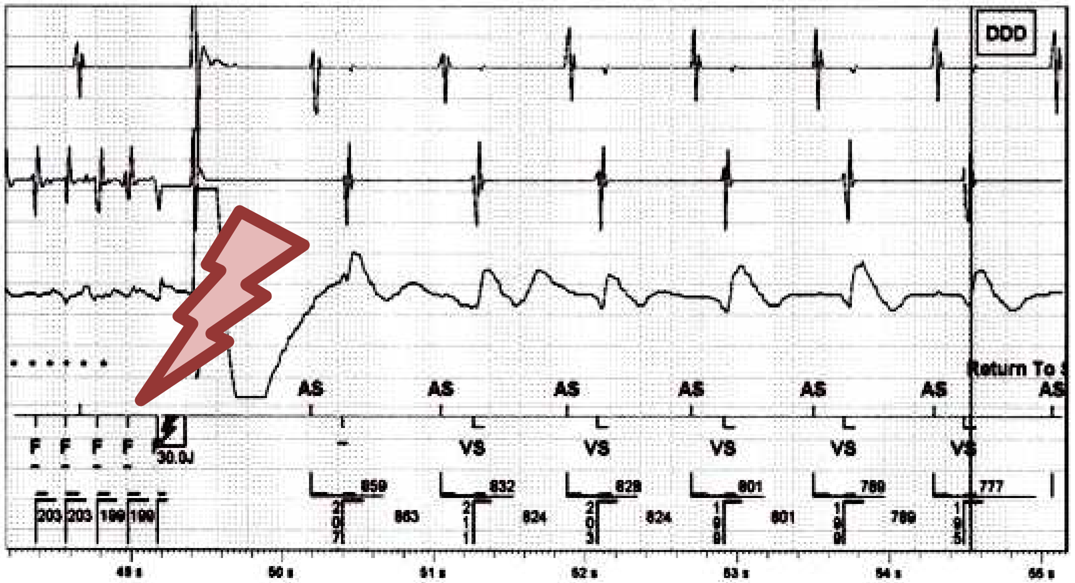
Episode: VT-2 (181 min⁻¹ / 330 ms) (Continued)

3 Nov 2015 20:41



1: A Sense Amp AutoGain (3.0 mm/mV)
2: V Sense Amp AutoGain (0.7 mm/mV)
3: Discrimination AutoGain (1.7 mm/mV)
4: Markers

Sweep Speed: 25 mm/s



EUROPEAN SOCIETY OF CARDIOLOGY®

Europace (2013) **15**, 1594–1600
doi:10.1093/europace/eut097

CLINICAL RESEARCH
Sudden death and ICDs

Left ventricular function improvement after prophylactic implantable cardioverter-defibrillator implantation in patients with non-ischaemic dilated cardiomyopathy

Wolfram Grimm[1]*, Nina Timmesfeld[2], and Elena Efimova[3]

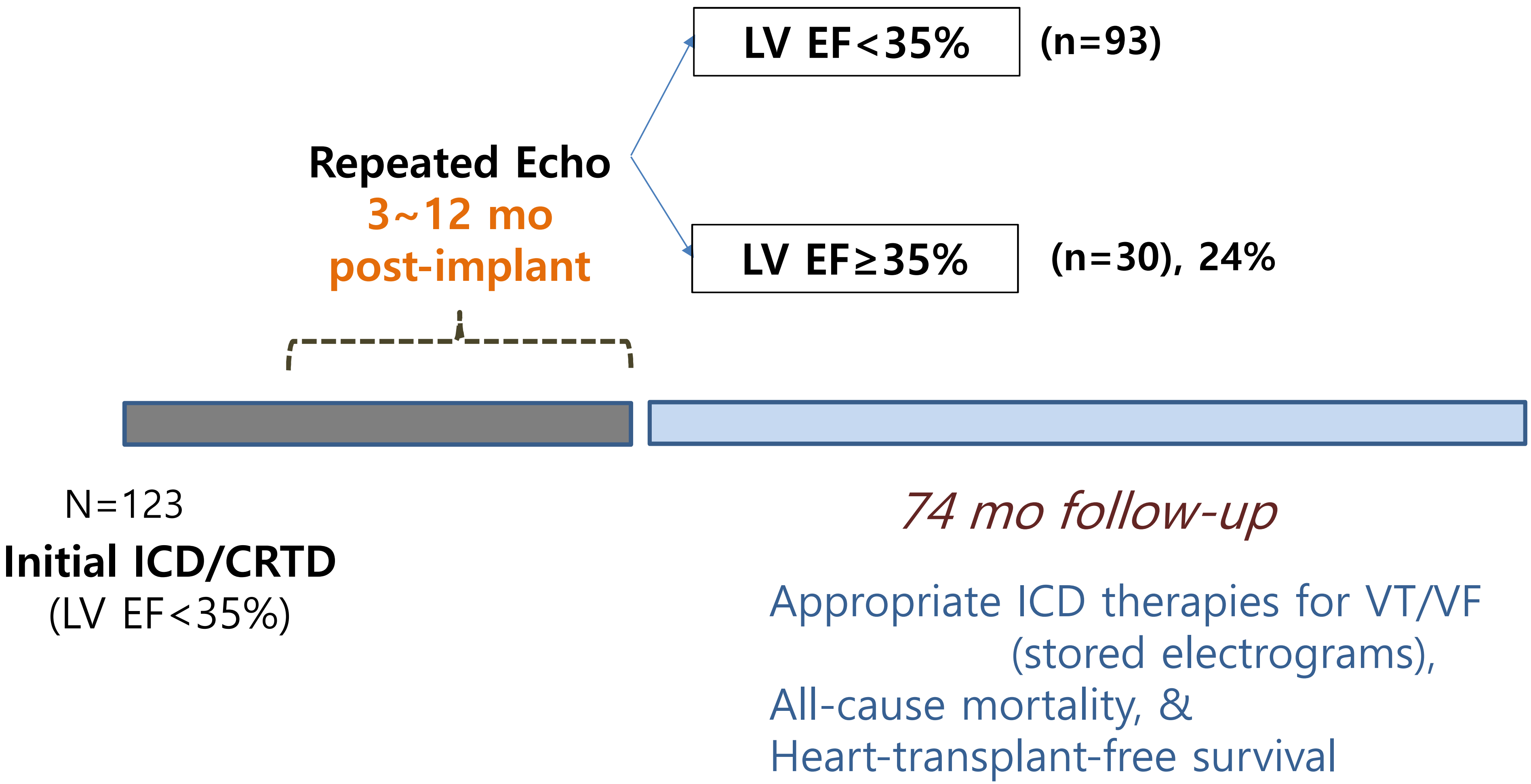
[1]Department of Cardiology, University Hospital of Marburg and Gießen, Philipps-University Marburg, Baldingerstraße, 35033 Marburg, Germany; [2]Institute for Medical Biometry and Epidemiology, Philipps-University Marburg, Marburg, Germany; and [3]Heart Center, Department of Electrophysiology, University of Leipzig, Leipzig, Germany

Received 19 January 2013; accepted after revision 27 March 2013; online publish-ahead-of-print 2 May 2013

Single center (Marburg, Germany) **ICD-Registry**

(1) 123 non-ischemic DCM with NYHA II~III & LV EF ≤35%
despite optimal medical therapy (OMT) ≥ 3 mont

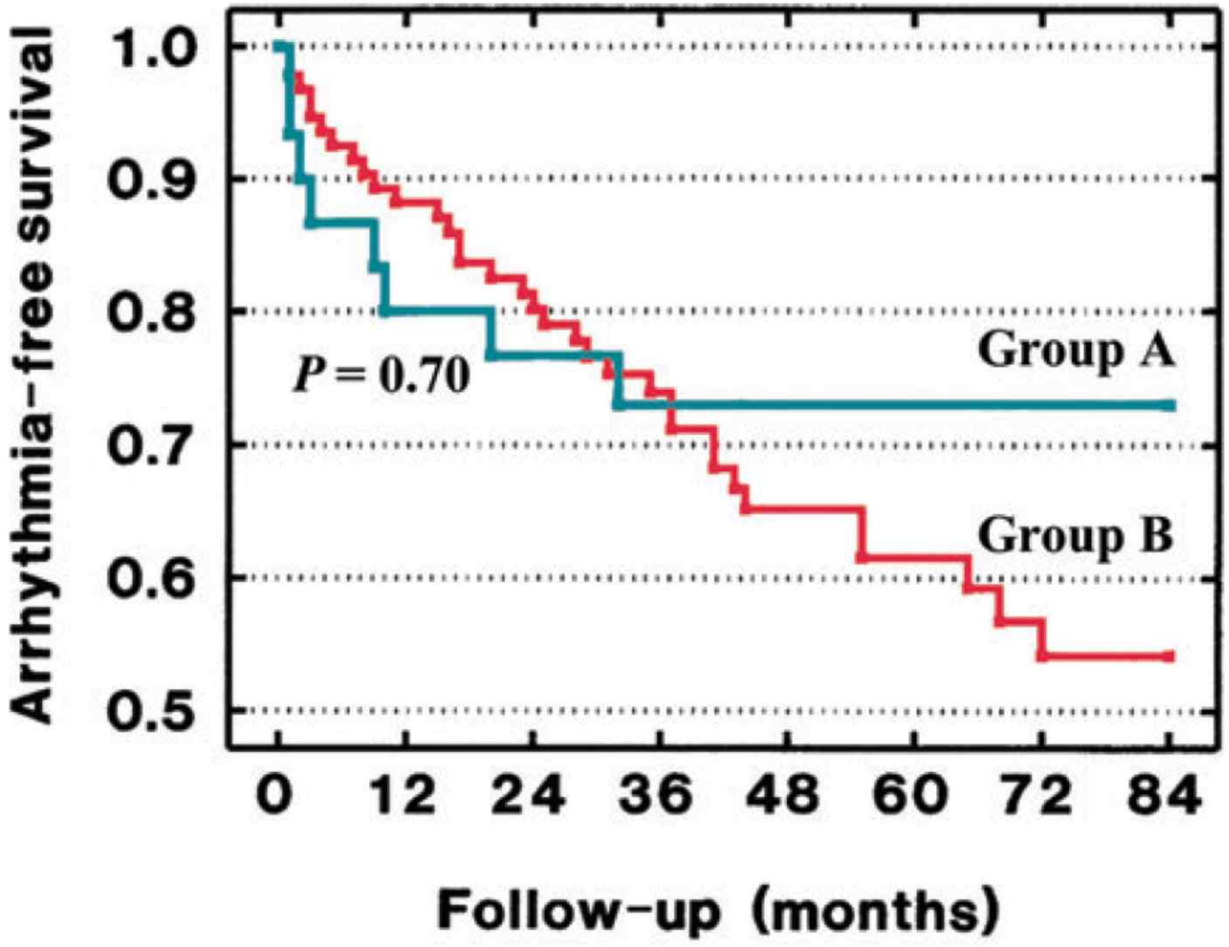
LVEF reassess & follow-up



Clinical outcomes

	All patients	No LV function improvement	LV function improvement	*P* value	HR (95% CI)[a]
Patients, *n*	123	93	30		
Follow-up duration (months)	74 ± 46	72 ± 48	81 ± 41		
Appropriate ICD therapy, *n* (%)	44 (36)	34 (37)	10 (33)	0.70	1.15 (0.57–2.33)
Inappropriate ICD therapy, *n* (%)	17 (14)	12 (13)	5 (17)	0.77	0.85 (0.30–2.43)
Total mortality, *n* (%)	33 (27)	30 (32)	3 (10)	0.019	3.75 (1.14–12.31)
Heart transplant, *n* (%)	9 (7)	9 (10)	0 (0)	0.066	

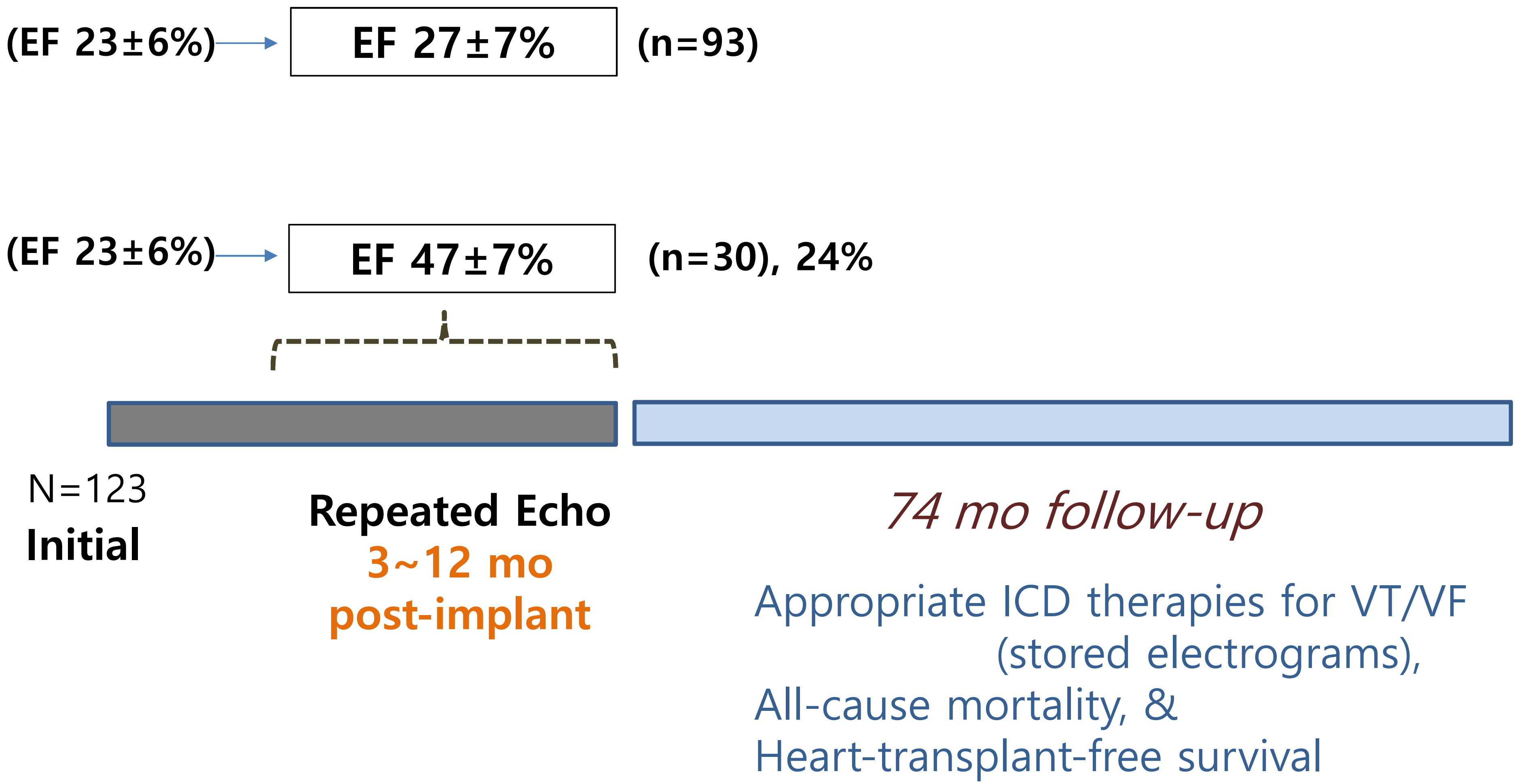
Arrhythmia-free survival



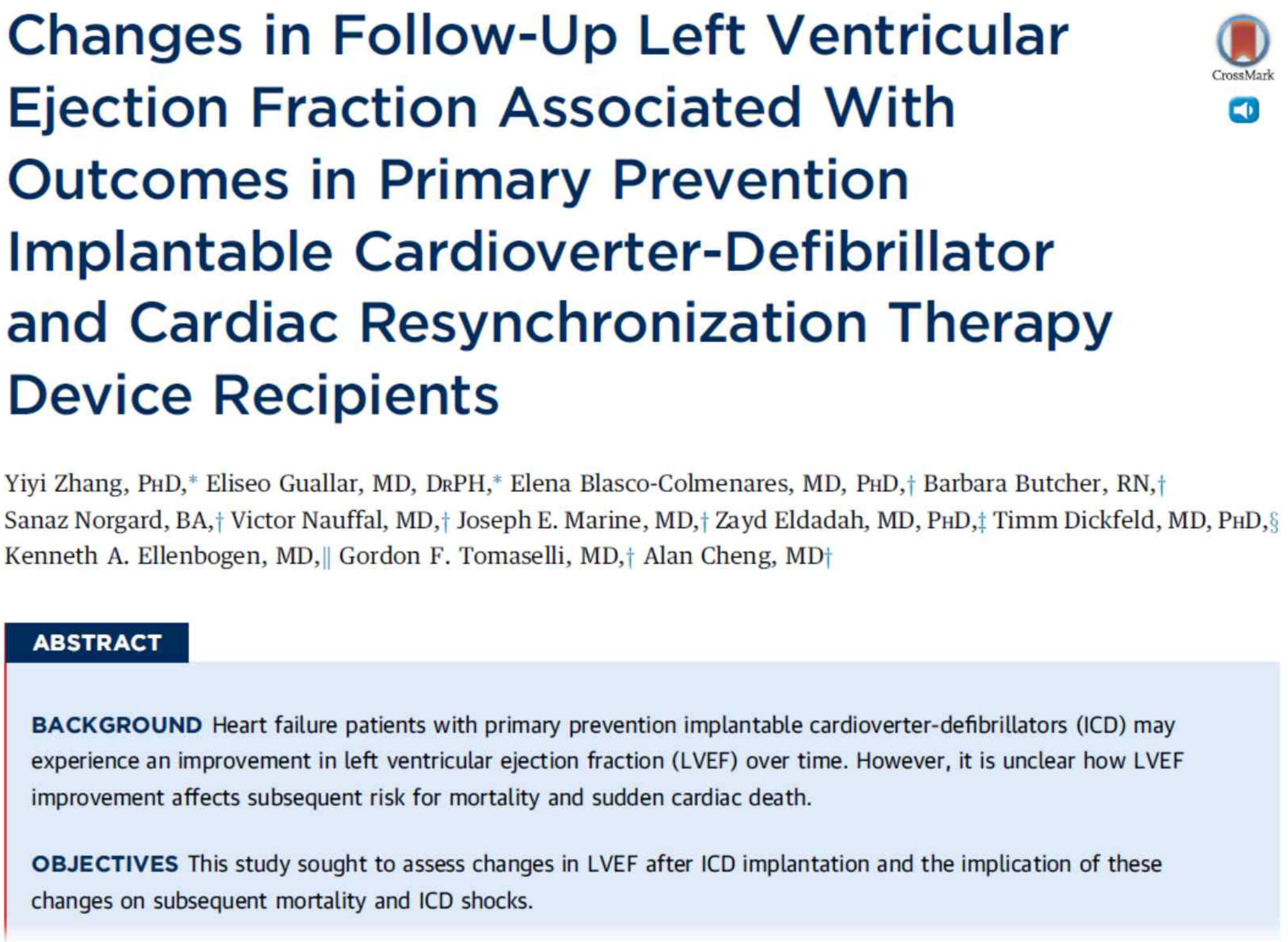
LV EF≥35%

LV EF<35%

LVEF reassess & follow-up



→ *Multicenter Prospective Study ?*



Changes in Follow-Up Left Ventricular Ejection Fraction Associated With Outcomes in Primary Prevention Implantable Cardioverter-Defibrillator and Cardiac Resynchronization Therapy Device Recipients

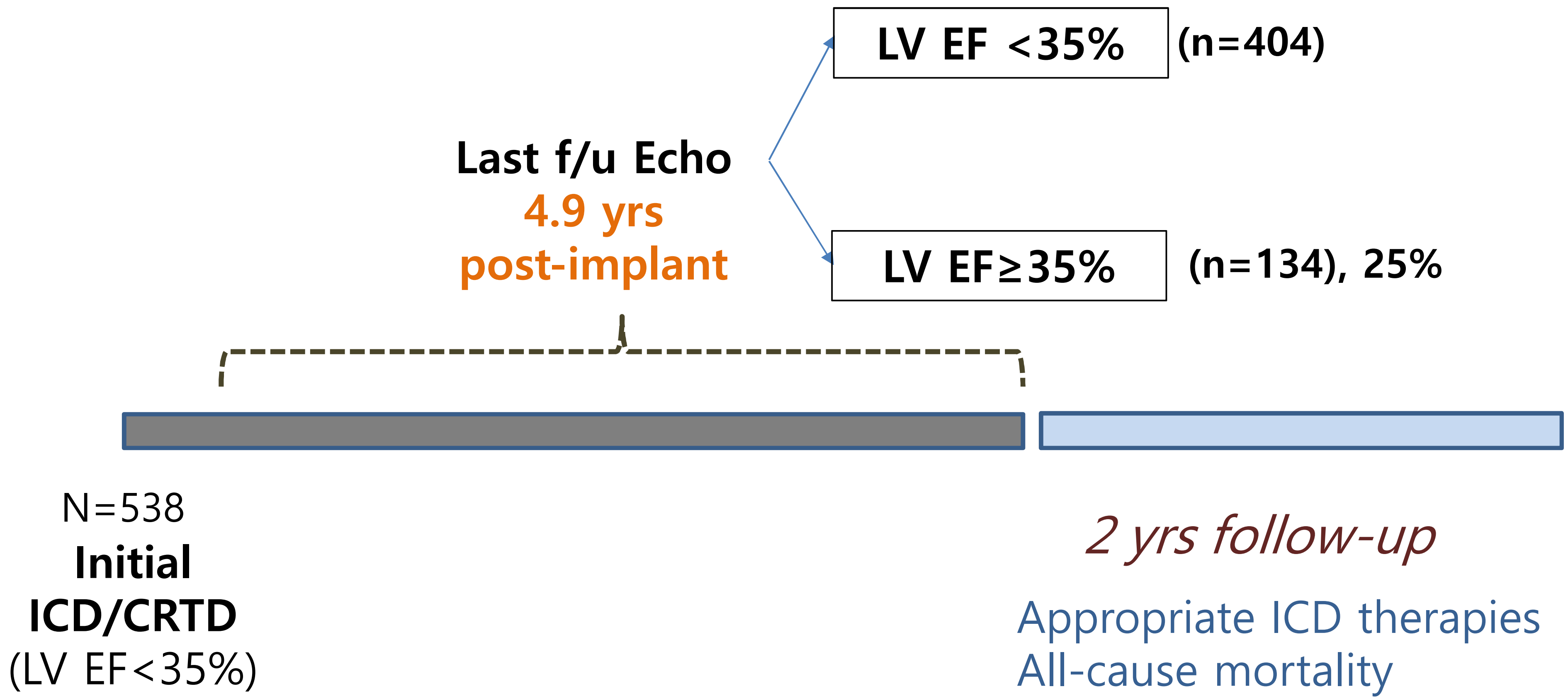
Yiyi Zhang, PhD,* Eliseo Guallar, MD, DrPH,* Elena Blasco-Colmenares, MD, PhD,† Barbara Butcher, RN,† Sanaz Norgard, BA,† Victor Nauffal, MD,† Joseph E. Marine, MD,† Zayd Eldadah, MD, PhD,‡ Timm Dickfeld, MD, PhD,§ Kenneth A. Ellenbogen, MD,|| Gordon F. Tomaselli, MD,† Alan Cheng, MD†

ABSTRACT

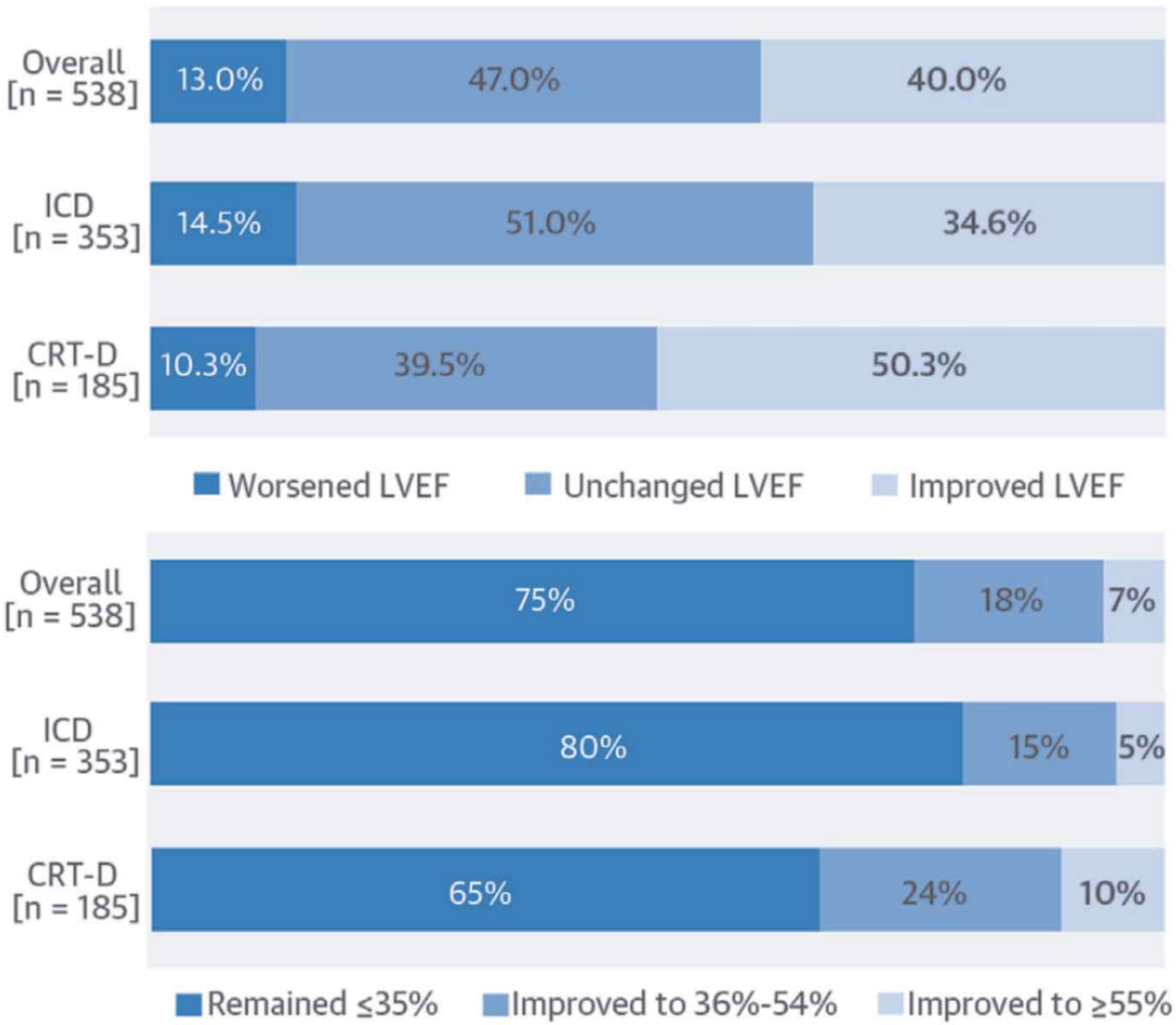
BACKGROUND Heart failure patients with primary prevention implantable cardioverter-defibrillators (ICD) may experience an improvement in left ventricular ejection fraction (LVEF) over time. However, it is unclear how LVEF improvement affects subsequent risk for mortality and sudden cardiac death.

OBJECTIVES This study sought to assess changes in LVEF after ICD implantation and the implication of these changes on subsequent mortality and ICD shocks.

LVEF reassess & follow-up



F/U LVEF after ICD implant



ICD shock

Last LVEF Measurement*	Overall (n = 464)			ICD Patients (n = 298)			CRT-D Patients (n = 166)		
	n (%)	Events	Incidence Rate†	n (%)	Events	Incidence Rate†	n (%)	Events	Incidence Rate†
≤35%	338 (73)	23	5.5	233 (78)	13	4.8	105 (63)	10	6.8
36%-54%	91 (20)	3	2.4	49 (16)	2	3.5	42 (25)	1	1.5
≥55%	35 (8)	1	1.7	16 (5)	0	0	19 (11)	1	2.6

*100 person-years

Outcomes After ICD Replacement for Primary Prevention of SCD

- Mayo Clinic & Beth Israel Deaconess Medical Center
- **January 2001 ~ June 2011**

- in **253 patients** (mean age, 68.3±12.7 years; 82% men)
- (1) undergoing ICD replacement
  (initially implanted for primary prevention)
  (2) no appropriate ICD therapy prior to replacement

Circ Arrhythm Electrophysiol. 2016;9:e003

LVEF reassess & follow-up

- LVEF obtained within **6 months before** or **3 months after** ICD generator replacement

Replacement
-6mo ~ +3mo
LV EF

Initial ICD
(LV EF<35%)

4.8 (±1.9) years

3.3 (1.8–5.3) years

Appropriate ICD therapy
: **Anti-tachycardia pacing or shock**
for VT/VF

Study cohort
Primary prevention ICD without appropriate ICD therapy prior to generator replacement
(N=135+118) ***N=253***

LV EF <35%
(n=181, 72%)

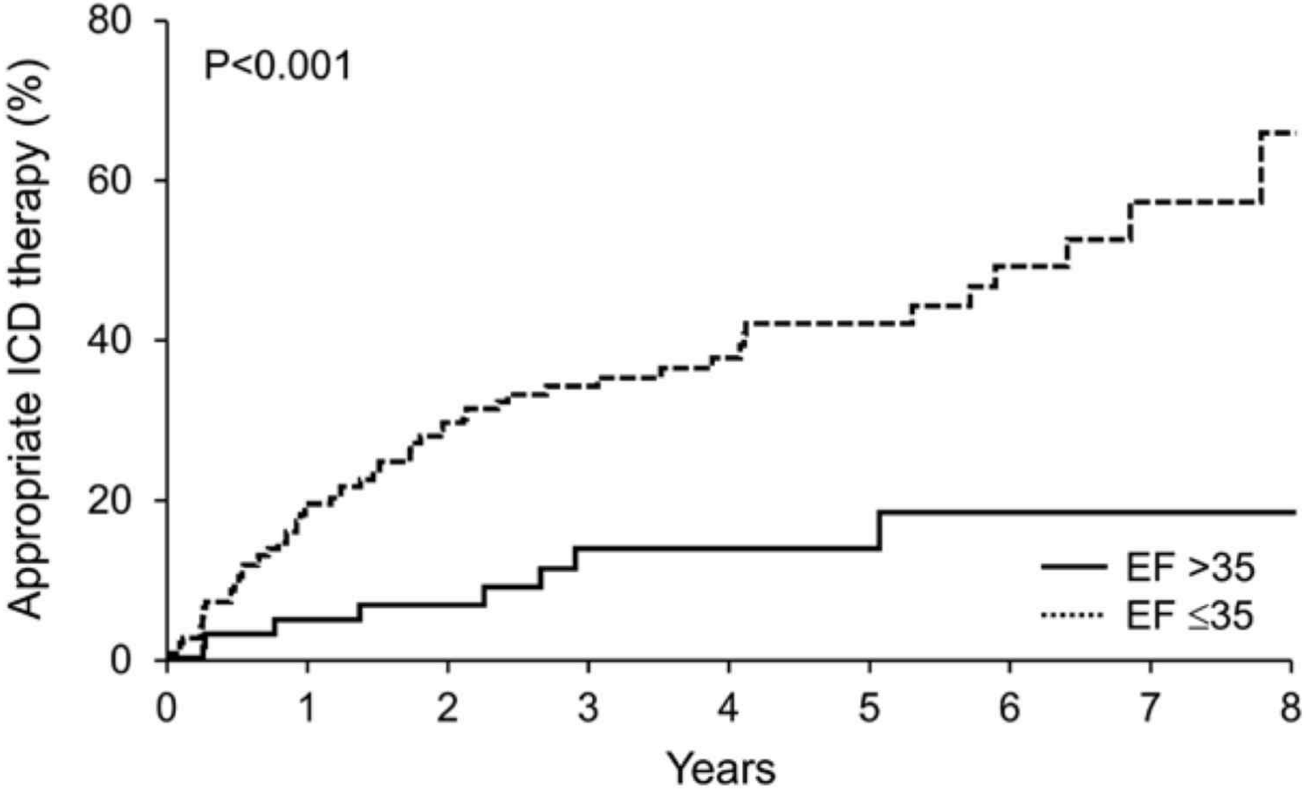
26.0±6.4%

LV EF ≥35%
(n=72, **28%**)

47.7±9.6%

Circ Arrhythm Electrophysiol. 2016;9:e003

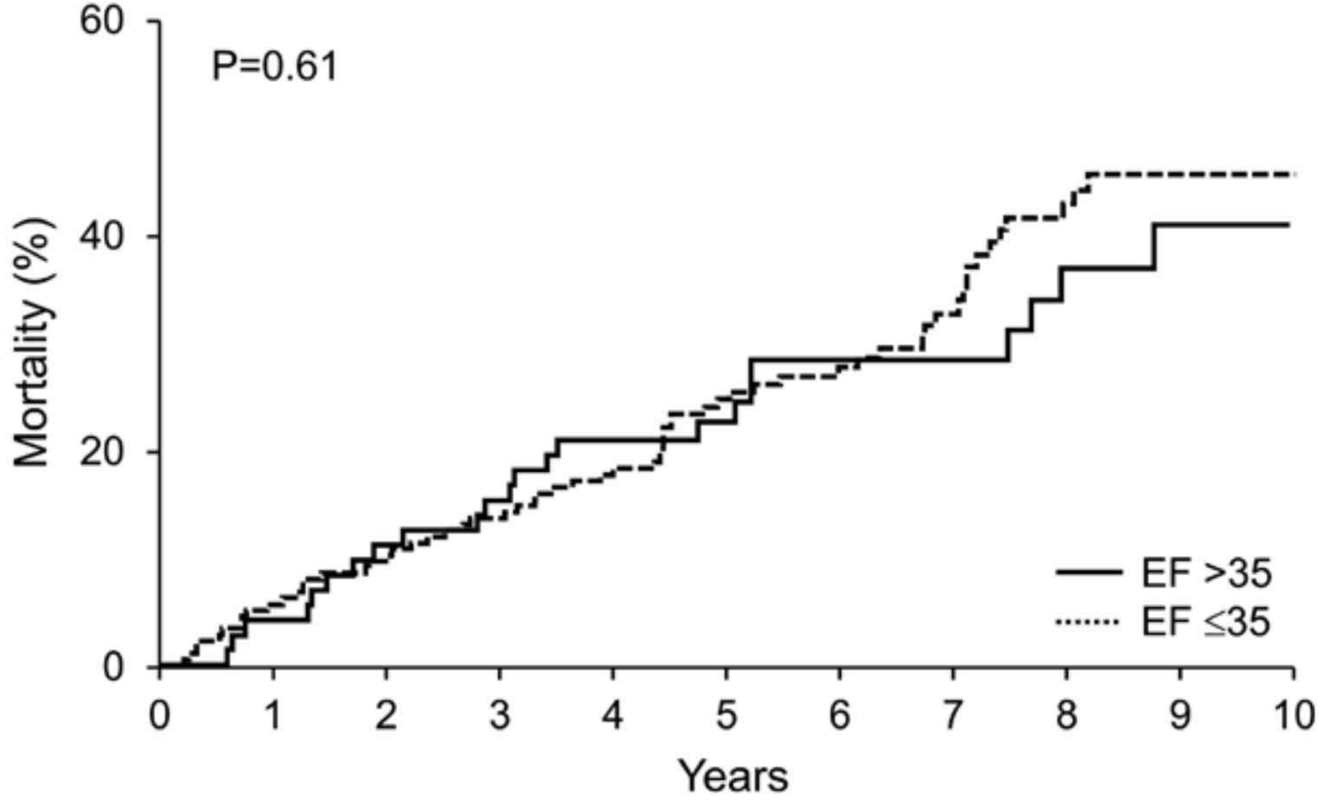
Rates of Appropriate ICD Therapy



No. at risk

EF >35	71	52	45	31	24	19	11	6	3
EF ≤35	172	116	84	63	44	30	19	5	3

Mortality



No. at risk

EF >35	72	69	64	61	54	43	31	27	22	12	7
EF ≤35	176	166	159	152	136	112	86	63	45	28	14

ICD settings

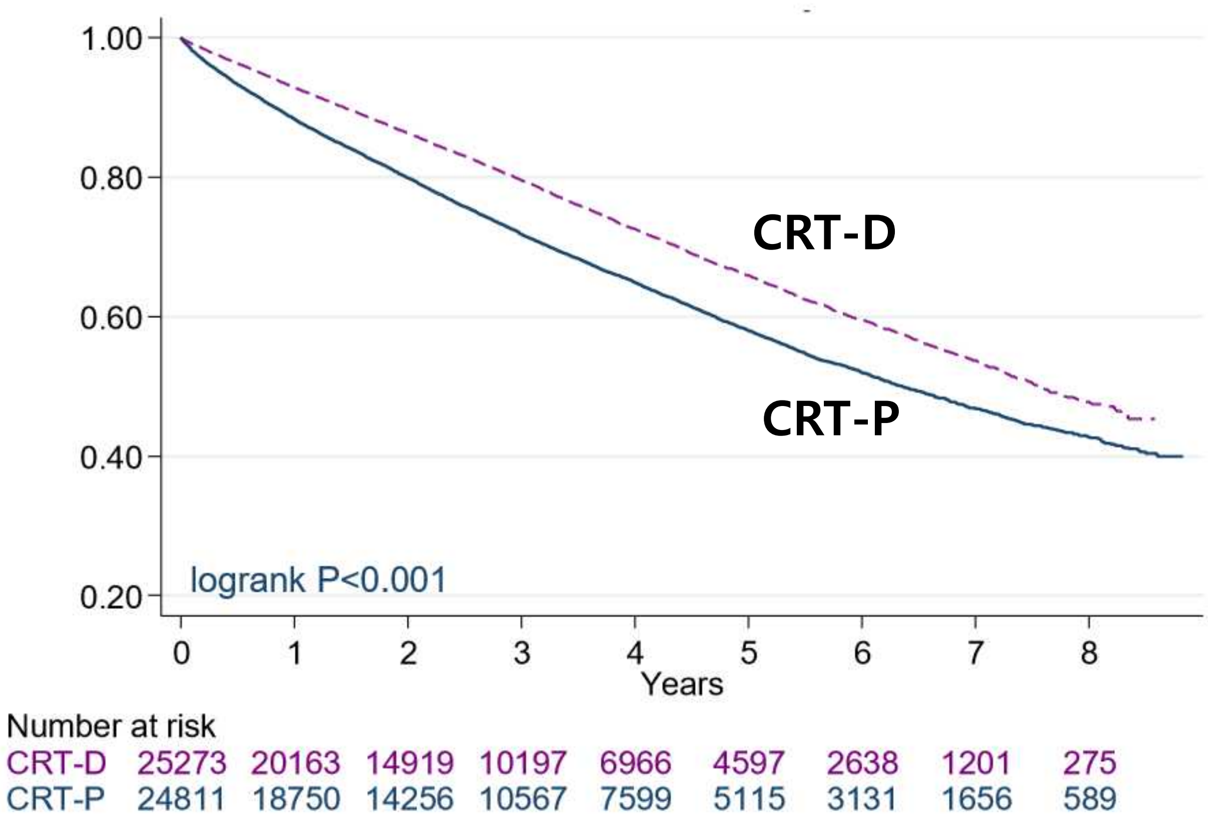
Clinical Characteristics*	Overall Cohort (n=253)	EF≤35% (n=181)	EF>35% (n=72)	*P* Value
Laboratory parameters				
Hemoglobin, g/dL	12.9 (1.9)	12.8 (2.0)	13.1 (1.8)	0.35
Serum sodium, mEq/L	139.4 (3.1)	139.3 (3.2)	139.6 (3.1)	0.57
Creatinine, mg/dL	1.4 (1.0)	1.5 (1.1)	1.3 (0.7)	0.040
Blood urea nitrogen, mg/dL	27.9 (18.1)	29.2 (19.7)	25.0 (13.8)	0.17
Estimated glomerular filtration rate, mL/min per 1.73 m^2	65.3 (27.4)	63.8 (27.1)	69.2 (28.0)	0.18
Programmed zone (median and minimum–maximum), beats per min				
VF zone	188 (170–316)	188 (170–316)	200 (185–220)	…
VT zone	164 (150–194) (n=72)	160 (150–194) (n=54)	170 (140–182) (n=18)	…

Cumulative rates of appropriate ICD therapy

- Cumulative rates of appropriate ICD therapy for a ventricular arrhythmia **increased over time** in the **group with EF>35%** (7%, 9%, and **14%** at 1,2, and **3 years** → annual rate of 5%)
- **Annual rate of 5%** is in the range for which guidelines recommend ICD therapy for many conditions

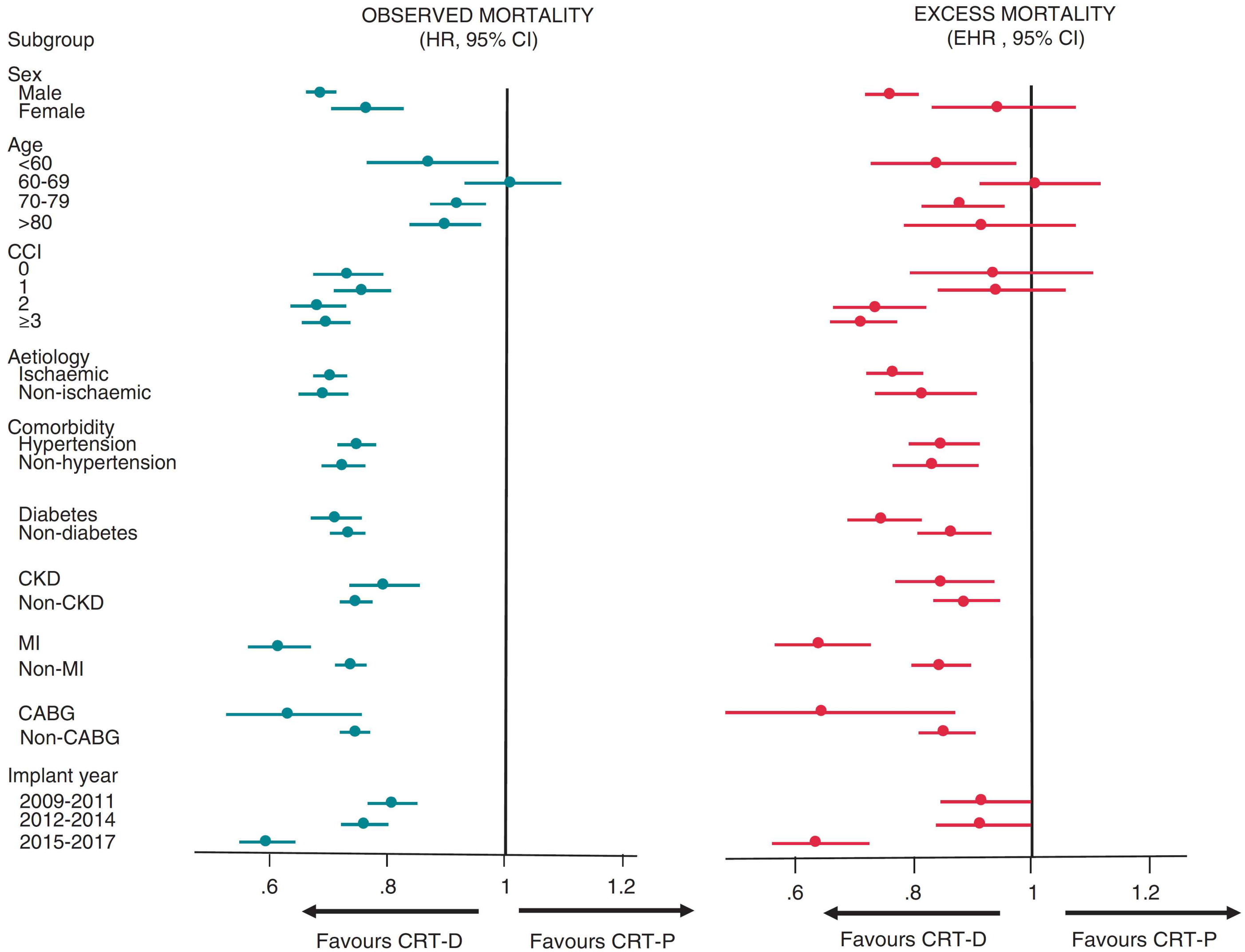
Survival after CRT: results from 50,084 implantations

- England Nationwide Cohort Undergoing CRT



Europace (2019) 21, 754–762

Survival after CRT: results from 50,084 implantations



Europace (2019) 21, 754–762

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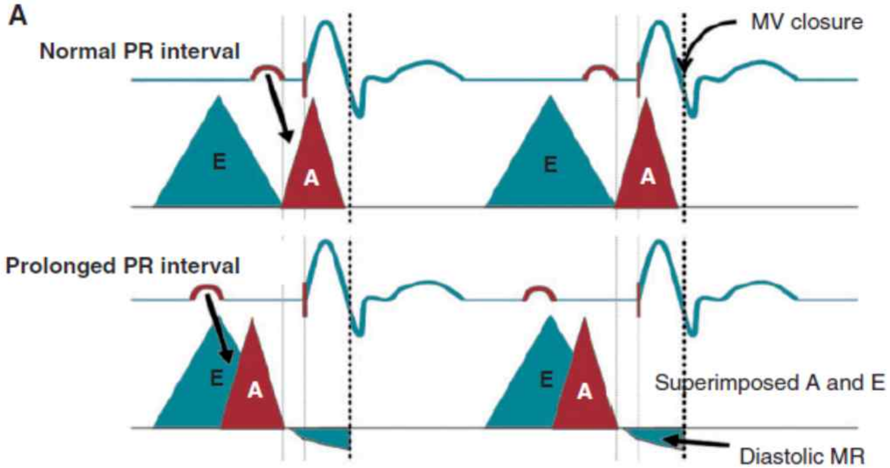
- **Automated optimization algorithm**
- More data: more patients for longer duration

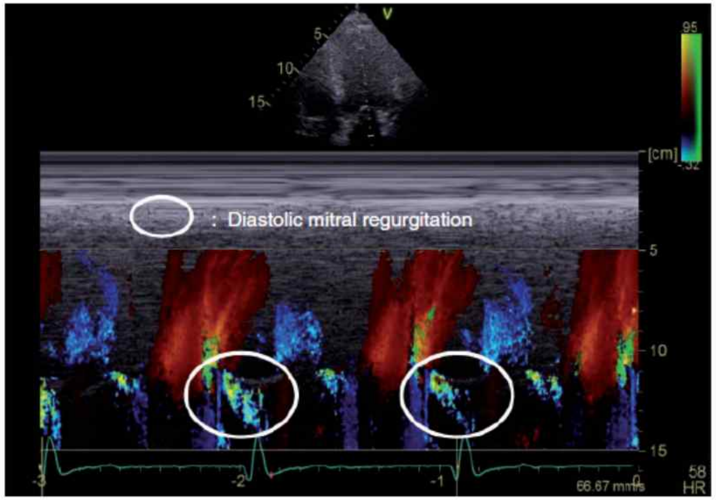
Hemodynamic implication of AV delay

- ✓ Prolonged AV delay → diastolic mitral regurgitation
- ✓ Shortened AV delay → fusion of E-and A- waves

Decrease in Cardiac Output

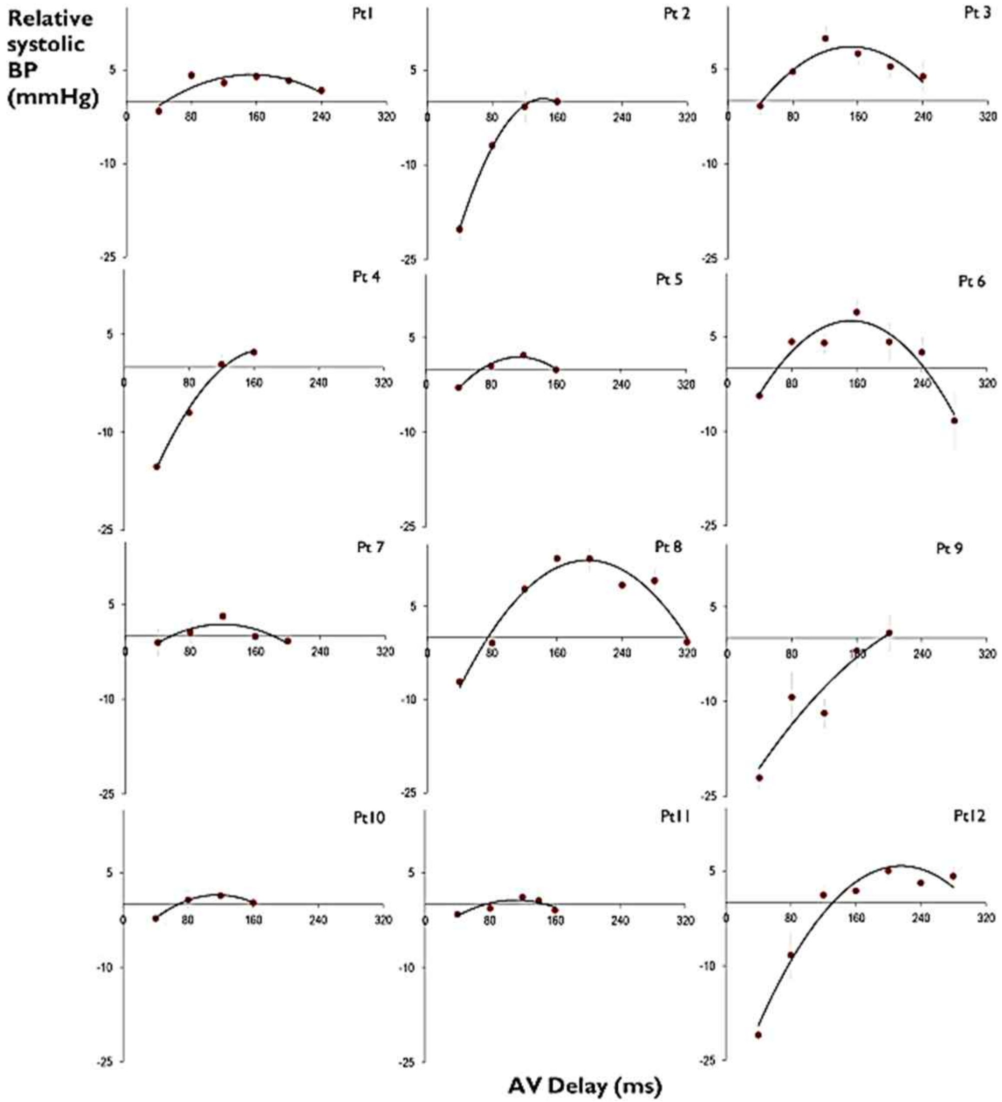


Barold et al. Europace(2008);10 (suppl 3) 88-95



F.C.W.M. Salden et al. Europace(2018) 20, 1067-1077

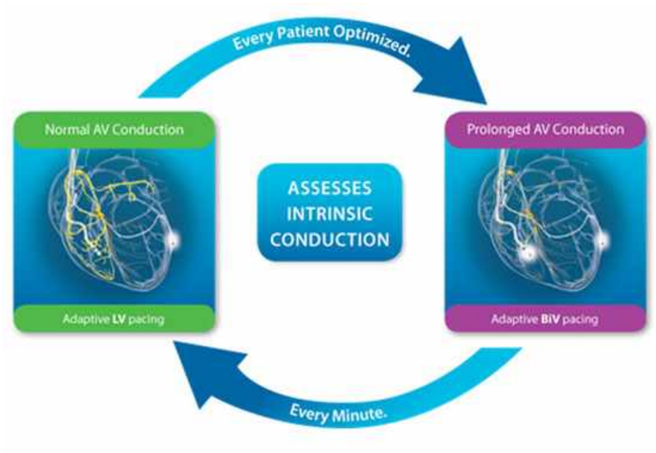
Optimization of AV delay required for better performance of HBP



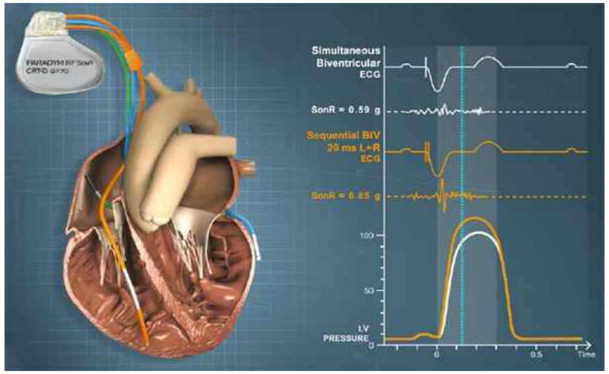
However, ...
No automatic algorithm in HBP device

Jacc: Clinical Electrophysiology 2015; 1: 582-591

Automated optimization of AV & VV delay in CRT

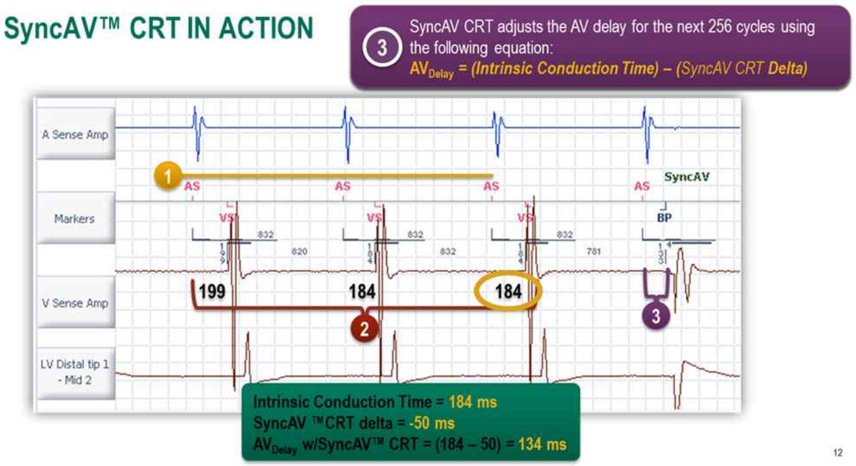


AdaptivCRT algorithm



SonR PEA sensor

SyncAV algorithm



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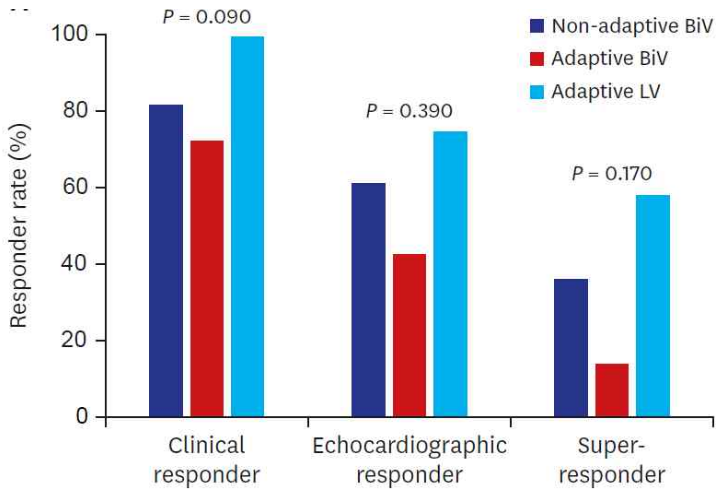
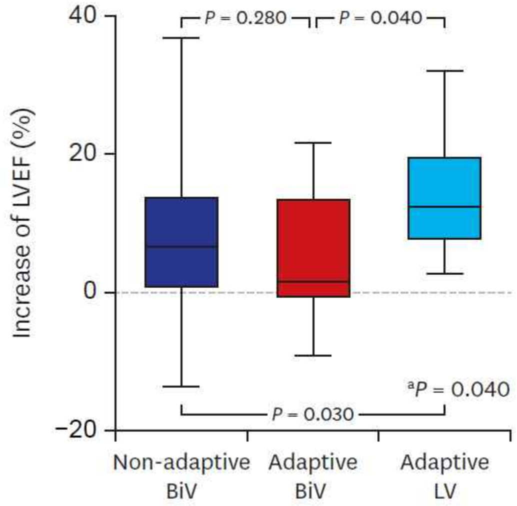
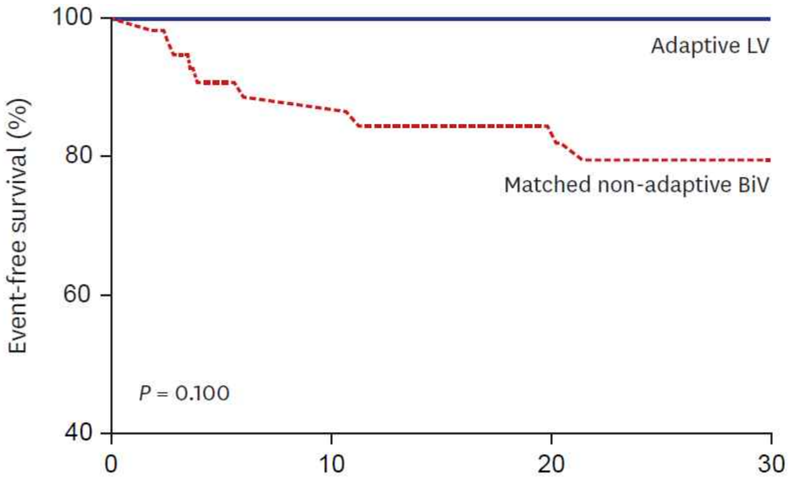
CRT with automated optimization function







HB Gwag, SJ Park, et al.
J Korean Med Sci. 2019 Jul 15;34(27):e

Advantages of CRT over HBP

- Implantation success rate
  ; particularly in anomalous structure or valve disease
- Stability of the Lead
- Concern for disease progression
  of conduction system
- Availability of defibrillator
- Automated optimization algorithm
- **More data: more patients for longer duration**

Data on HBP

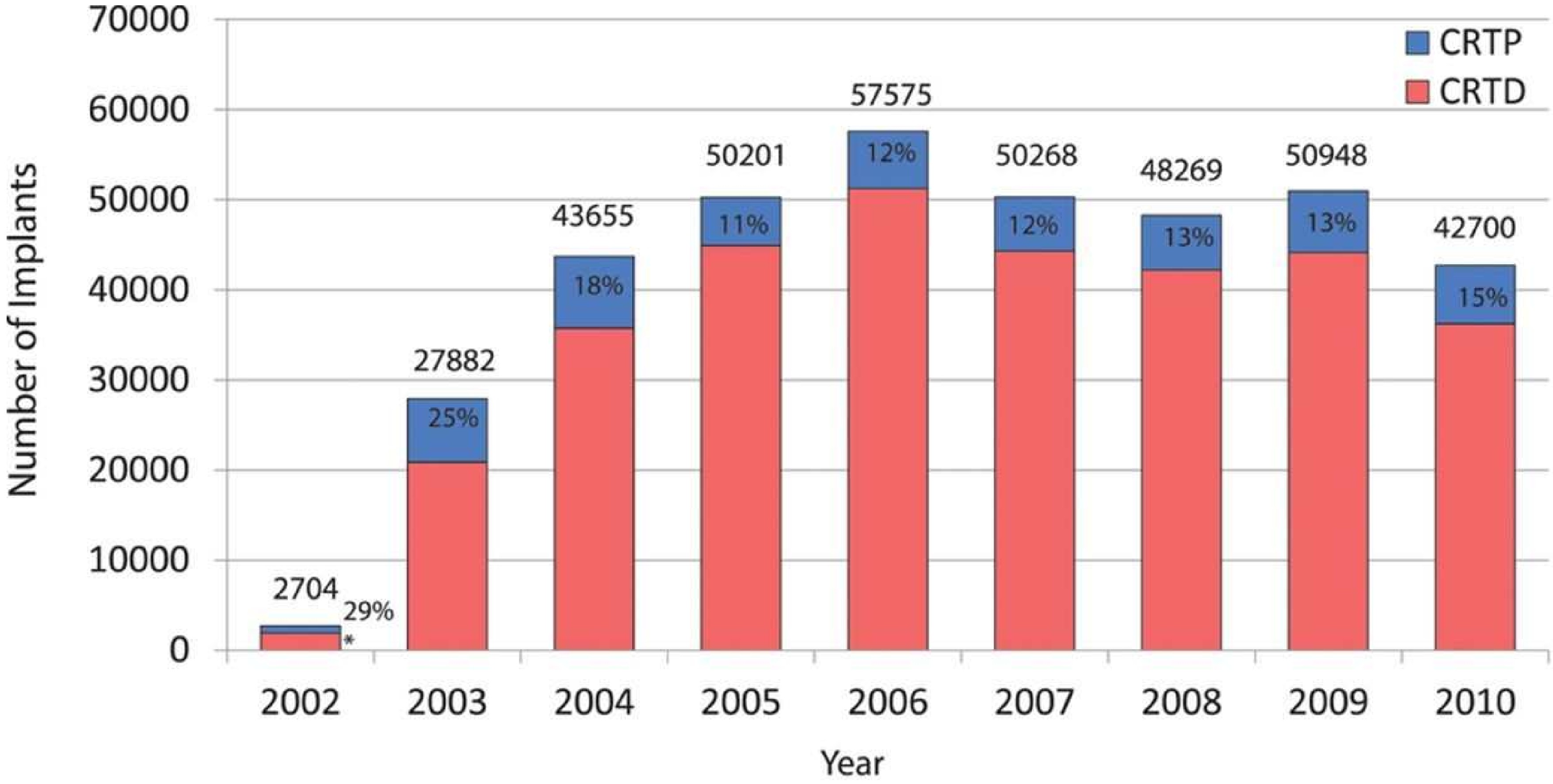
All patients (n=1,156)

HF (+)=442 (38%)

Study	Number of Patients, n	Overall Reported Technical Success Rate, n (%)	Reported Selective HBP Rate, n (%)	Threshold at Time of Implant, V (0.5 ms Pulse)	Distribution of Heart Failure Within Study Population	Notes
Cantu et al 2006[26]	17			(selective) (nonselective)	5 (29%) had EF <40%	All patients had suprahisian block
Catanzariti et al 2006[28]	24			5	13 (56%) reported	
Zanon et al 2006[50]	26				26 (100%) reporte	
Lustgarten et al 2010[53]	10	10 (100)	10 (100)	1.3±0.9	10 (100%) reported to have heart failure	All patients had conventional CRT indications
Kronborg et al 2011[41]	38	32 (84)	4 (13)	2.3±1.0 (selective) 1.5±1.2 (non-selective)	32 (100%) reported to have EF >40%	All patients had suprahisian block
Zanon et al 2011[54]	307	Not known	87 (28)	2.5±2.3 (selective) 1.3±1.1 (nonselective)	58 (19%) reported to have heart failure	All patients had suprahisian block
Lustgarten et al (2015)[45]	29	17 (59) achieved permanent HBP with QRS narrowing		3 to 4 (selective) 1 to 1.5 (nonselective)	21 (72%) reported to have cardiomyopathy	28 patients (97%) had left bundle branch block
Sharma et al 2015[37]	94	75 (80)	34 (45)	1.35±0.9	24 (32%) reported to have heart failure	44 (59%) had atrioventricular conducting system disease
Vijayaraman et al 2015[44]	100	84 (84)	22 (26)	1.4±1 V	Mean ejection fraction 54±10%	46 patients had atrioventricular nodal block, 54 patients had infranodal atrioventricular block
Ajijola et al 2017[46]	21	16 (76)	1 (6)	1.9±1.2 V at 0.6±0.2 ms	20 (95%) reported to have EF <35%	All patients reported to have an indication for CRT
Huang et al 2017[52]	52	42 (81)	38 (90)	1.5±1	42 (100%) reported to have heart failure	All patients had AF and underwent atrioventricular node ablation
Sharma et al 2018[47]	106	95 (90)	47 (50)	1.4±0.9 at 1 ms (His bundle capture) 2±1.2 at 1 ms (narrowing of BBB)	106 (100%) reported to have cardiomyopathy (LVEF 30±10% at baseline)	All patients had a CRT indication
Abdelrahman et al 2018[39]	332	304 (92)	115 (38)	1.30±0.85 at 0.79±0.26 ms	85 (26%) reported to have heart failure	Includes patients with wide range of pacemaker indications

AF indicates atrial fibrillation; BBB, bundle branch block; CRT, cardiac resynchronization therapy; EF, ejection fraction; HBP, His bundle pacing; LVEF, left ventricular ejection fraction.

Data on CRT



***US trends** in CRT device implantation*

Circ Arrhythm Electrophysiol. 2016;9:e003108.

Data on CRT

Country	ISO code	Number of CRT implanting centres 2013		CRT implantations 2013		Total CRT implantations 2013		Development potential—target number of CRT implantations . . .		CRT implantations per mil inhabitants				
		Absolute number	Per mil inhabitants	CRT-P implantations Absolute number	CRT-D implantations Absolute number	Absolute number	Per mil inhabitants	To attain mean ESC area level	To attain mean EU-28 level	2009	2010	2011	2012	2013
Albania[a]	AL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Algeria	DZ	8	0.21	31	33	64	2	2266	4155	N/A	N/A	N/A	N/A	2
Armenia	AM	2	0.65	0	10	10	3	182	334	3	2	3	6	3
Austria	AT	18	2.19	281	897	1178	143	–	–	113	119	117	107	143
Azerbaijan	AZ	2	0.21	0	17	17	2	570	1046	N/A	2	2	N/A	2
Belarus[b]	BY	5	0.52	N/A	N/A	54	6	573	1050	5	4	5	4	6
Belgium	BE	35	3.35	397	824	1221	117	–	–	N/A	49	58	77	117
Spain	ES	130	2.74	857	1688	2545	54	2818	5168	41	41	56	53	54
Sweden	SE	N/A	N/A	431	536	967	100	–	1052	84	81	N/A	49	100
Switzerland	CH	31	3.88	157	320	477	60	–	872	70	73	74	66	60
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9	8	8	23	N/A
Turkey[a]	TR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ukraine	UA	13	0.29	67	22	89	2	2652	4863	N/A	1	1	1	2
United	GB	109	1.72	3792	3970	7762	122	–	–	95	105	105	110	122

Total cases=51,274; CRT-P 12,766 + CRT-D 38,429 in 2013

[a]These 10 countries did not submit data on CRT implantations in 2013.
[b]Belarus, and Cyprus reported only total CRT implantation numbers and Germany only the numbers for CRT-D implantations.

Statistics on the use of CRT: report from the EHRA

Europace (2015) 17, i1–i75

Summary

- CRT, higher success rate of implantation
  no concern for disease progression
  of conduction system

- Defibrillator can be adopted into CRT

- Automated optimization algorithm in CRT

- CRT, more data in more patients for longer period

경청해 주셔서 감사합니다