Device Therapy in Heart Failure

Thoranis Chantrarat MD

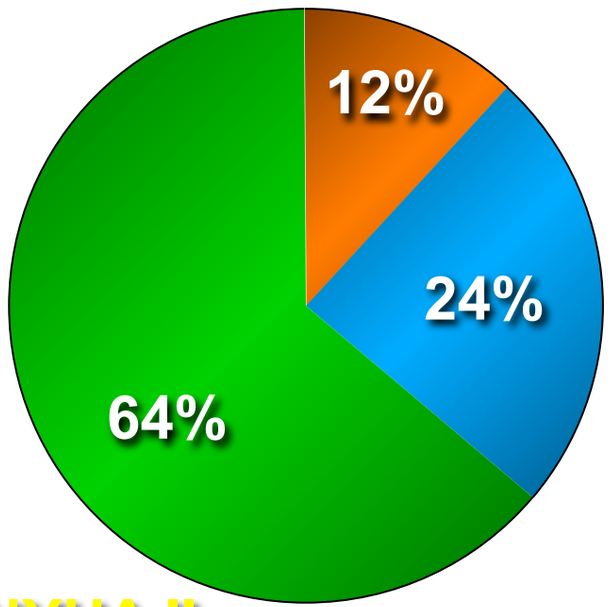
Scope of presentation

- Natural history of heart failure
- Primary and secondary prevention
- ICD and its indication
- CRT and its indication

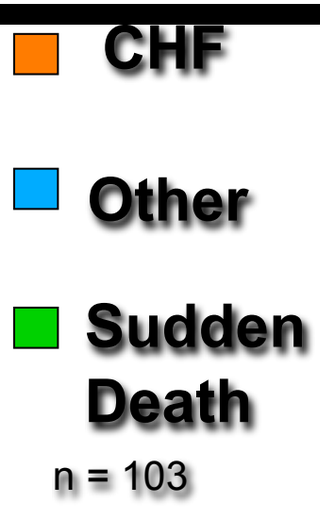
Severity of Heart Failure

Modes of Death

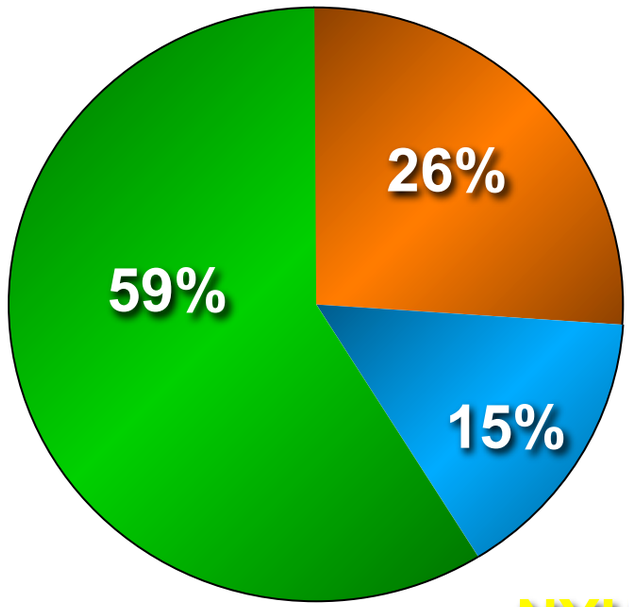
PMK Cardiology Review



NYHA II



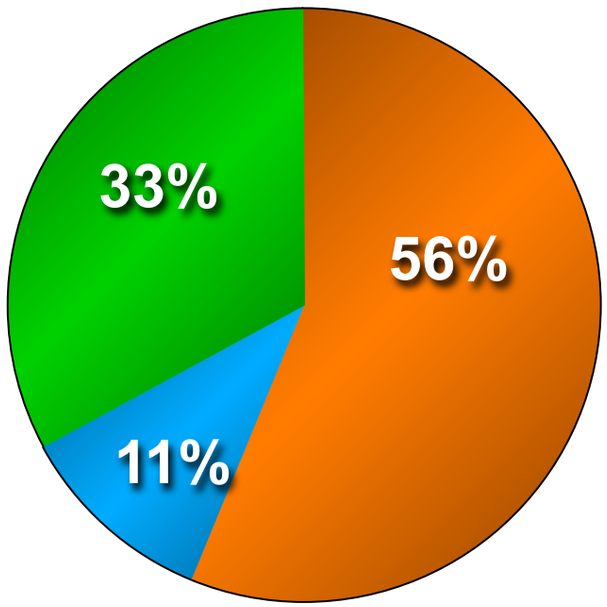
n = 103

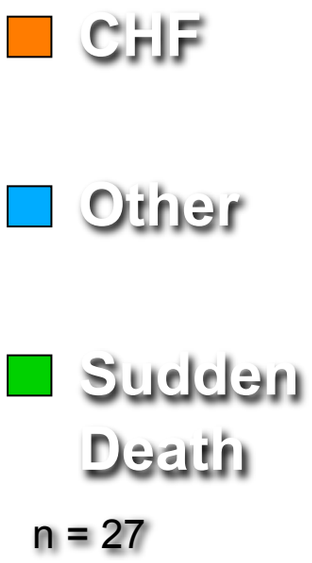


NYHA III

n = 103

NYHA IV





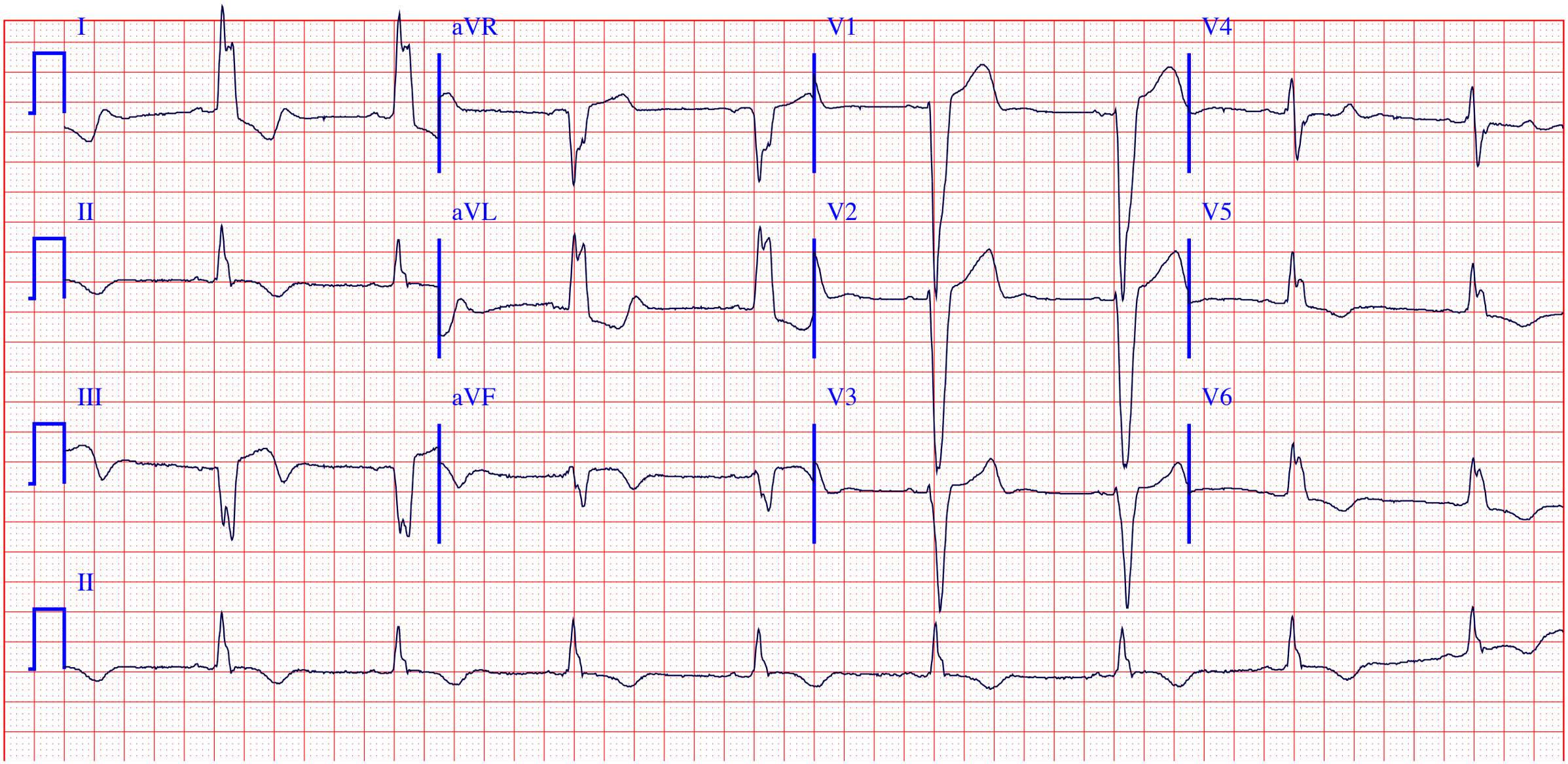
n = 27

MERIT-HF Study Group. Effect of Metoprolol CR/XL in chronic heart failure: Metoprolol CR/XL randomized intervention trial in congestive heart failure (MERIT-HF). *LANCET*. 1999;353:2001-07.

Etiology of Heart Failure

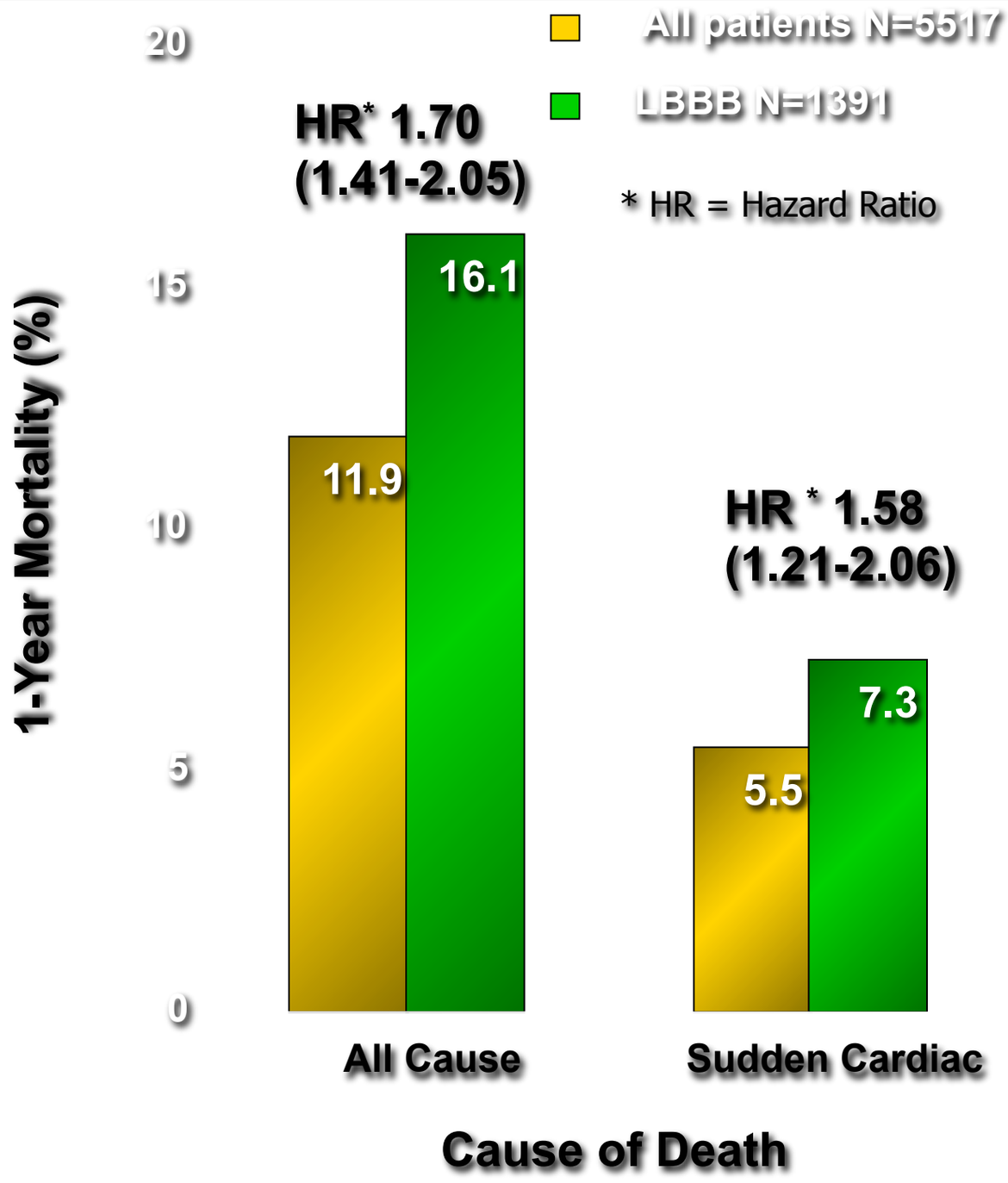
- Ischemic Heart Disease
- Hypertension
- Idiopathic Cardiomyopathy
- Infections (e.g., viral myocarditis)
- Toxins (e.g., alcohol or cytotoxic drugs,thyroid)
- Valvular Disease
- Prolonged Arrhythmias

A 65 year old with ischemic cardiomyopathy and LVEF of 25% ,FcIII and on optimal medical therapy for 1 year.



Increased Mortality Rate with LBBB

- Increased 1-year mortality with presence of complete LBBB (QRS > 140 ms)
- Risk remains significant even after adjusting for age, underlying cardiac disease, indicators of HF severity, and HF medications

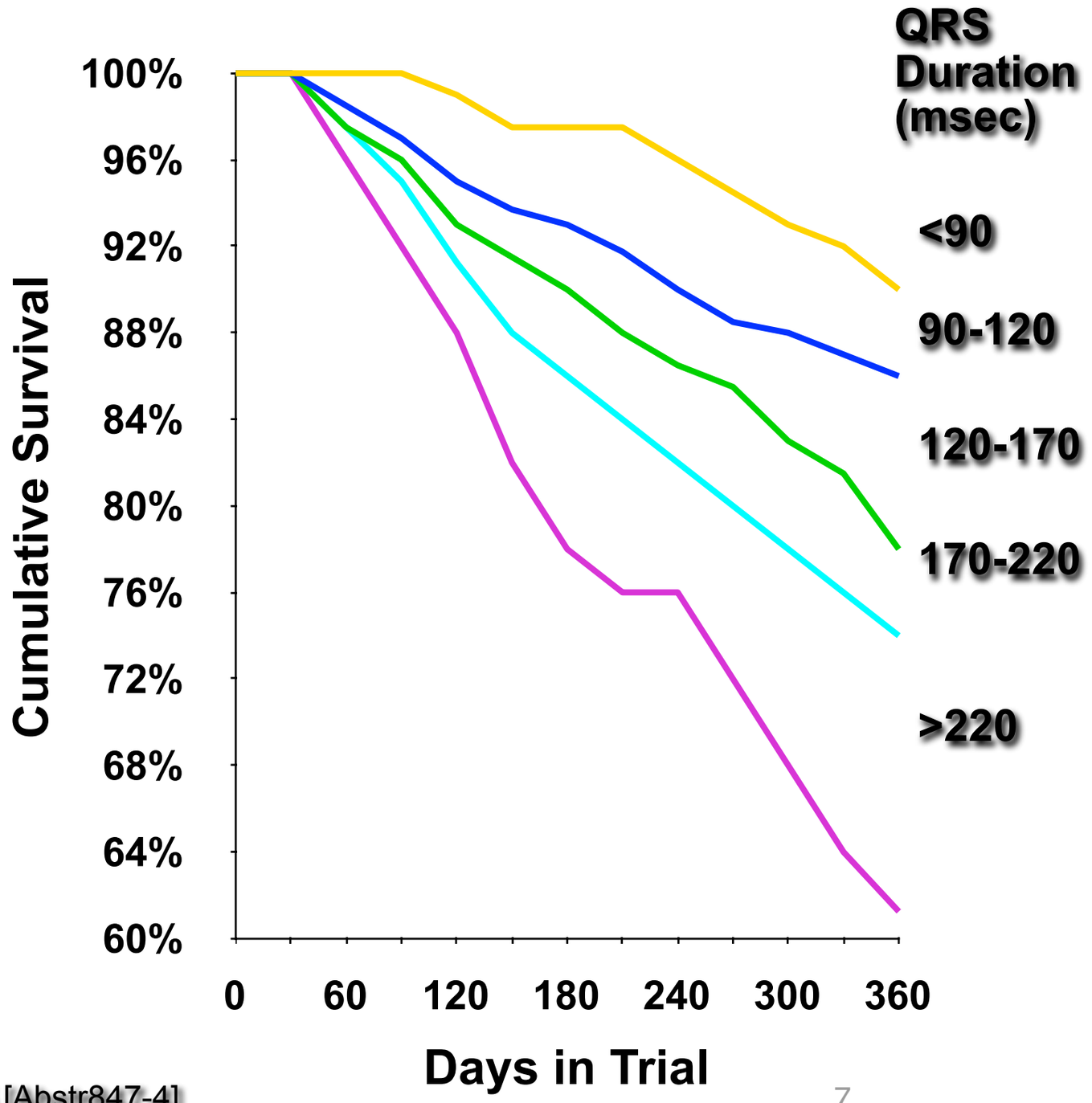


Baldasseroni S, Opasich C, Gorini M, et al. Am Heart J 2002;143:398-405

Wide QRS – Proportional Mortality Increase

Vesnarinone Study[1] (VEST study analysis)

- NYHA Class II–IV patients
- 3,654 ECGs digitally scanned
- Age, creatinine, LVEF, heart rate, and QRS duration found to be independent predictors of mortality
- Relative risk of widest QRS group 5x greater than narrowest



[1] Gottipaty V, Krelis S, Lu F, et al. JACC 1999;33(2) :145 [Abstr847-4].

Current Guidelines

- HFSA
- ACCF/AHA/HRS
- ESC/EHRA 2015

Class I recommendation

HFSA	ACCF/AHA/HRS	ESC/EHRA
NYHA II – III LVEF≤35% Sinus rhythm QRS≥150ms Not due to RBBB	NYHA III and ambulatory NYHA IV LVEF≤35% Sinus rhythm QRS≥150ms LBBB	NYHA II, III, and ambulatory NYHA IV LVEF≤35% Sinus rhythm QRS≥150ms LBBB
	NYHA II LVEF≤35% Sinus rhythm QRS≥150ms LBBB	NYHA II, III, and ambulatory NYHA IV LVEF≤35% Sinus rhythm QRS 120 - 150 ms LBBB
		NYHA III, and ambulatory NYHA IV LVEF≤35% Upgrade from IPG or ICD High percentage of ventricular pacing

Class I recommendation

HFSA	ACCF/AHA/HRS	ESC/EHRA
NYHA II – III LVEF≤35% Sinus rhythm QRS≥150ms Not due to RBBB	NYHA III and ambulatory NYHA IV LVEF≤35% Sinus rhythm QRS≥150ms LBBB	NYHA II, III, and ambulatory NYHA IV LVEF≤35% Sinus rhythm QRS≥150ms LBBB
	NYHA II LVEF≤35% Sinus rhythm QRS≥150ms LBBB	NYHA II, III, and ambulatory NYHA IV LVEF≤35% Sinus rhythm QRS 120 - 150 ms LBBB
		NYHA III, and ambulatory NYHA IV LVEF≤35% Upgrade from IPG or ICD High percentage of ventricular pacing

Class I recommendation

HFSA	ACCF/AHA/HRS	ESC/EHRA
NYHA II – III LVEF≤35% Sinus rhythm QRS≥150ms Not due to RBBB	NYHA III and ambulatory NYHA IV LVEF≤35% Sinus rhythm QRS≥150ms LBBB	NYHA II, III, and ambulatory NYHA IV LVEF≤35% Sinus rhythm QRS≥150ms LBBB
	NYHA II LVEF≤35% Sinus rhythm QRS≥150ms LBBB	NYHA II, III, and ambulatory NYHA IV LVEF≤35% Sinus rhythm QRS 120 - 150 ms LBBB
		NYHA III, and ambulatory NYHA IV LVEF≤35% Upgrade from IPG or ICD High percentage of ventricular pacing

Class IIa recommendation

ACCF/AHA/HRS	ESC/EHRA
NYHA II - ambulatory NYHA IV LVEF≤35% Sinus rhythmQRS 120–149 ms	NYHA II, III, and ambulatory NYHA IV LVEF≤35% Sinus rhythm QRS≥150ms Non-LBBB
NYHA III and ambulatory NYHA IV LVEF≤35% Atrial fibrillation Requires ventricular pacing or after AV nodal ablation or pharmacological rate will allow near 100% pacing	NYHA II, III, and NYHA IV LVEF≤35% Permanent atrial fibrillation Intrinsic QRS ≥120ms A BiV pacing as close to 100% as possible shall be achieved; AV junction ablation should be added in case of incomplete BiV pacing

Class IIa recommendation

PM

ACCF/AHA/HRS	ESC/EHRA
	No NYHA class specification LVEF≤35% Any underlying rhythm Indication to IPG or ICD, and high percentage of ventricular pacing expected
NYHA III and ambulatory NYHA IV Indication for conventional pacing and anticipated significant (>40%) ventricular pacing	No NYHA class specification LVEF≤35% Permanent atrial fibrillation Uncontrolled heart rate Planned AV junction ablation

Class IIb recommendation

HFSA	ACCF/AHA/HRS	ESC/EHRA
NYHA IV ambulatory LVEF≤35% QRS≥150ms	NYHA III and ambulatory NYHA IV LVEF≤30% Sinus rhythm QRS 120–149 ms Non-LBBB morphology	NYHA II, III, and ambulatory NYHA IV LVEF≤35% Sinus rhythm QRS 120 - 150 ms Non-LBBB
NYHA II – ambulatory IV LVEF≤35% QRS≥120ms and ≤150ms	NYHA II LVEF≤35% Sinus rhythm QRS≥150 ms Non-LBBB morphology	
NYHA II - III LVEF≤35% Atrial fibrillation QRS≥120 ms		
No NYHA Class specification Chronic ventricular pacing Reduced LVEF	NYHA I LVEF≤30% Sinus rhythm QRS≥150 ms LBBB Ischemic cause	

2015 ESC

Recommendations	Class[a]	Level[b]
CRT is recommended to reduce all-cause mortality in patients with an LVEF ≤35% and LBBB despite at least 3 months of optimal pharmacological therapy who are expected to survive at least 1 year with good functional status:		
– With a QRS duration >150 ms	I	A
– With a QRS duration of 120–150 ms	I	B

ESC 2015

CRT should or may be considered to reduce all-cause mortality in patients with an LVEF ≤35% without LBBB despite at least 3 months of optimal pharmacological therapy who are expected to survive at least 1 year with good functional status:		
– With a QRS duration >150 ms	**IIa**	**B**
– With a QRS duration of 120–150 ms	**IIb**	**B**

AF and CHF 2015

Recommendations	Class[a]	Level[b]
CRT should be considered to reduce all-cause mortality in patients with chronic HF, QRS ≥120 ms and LVEF ≤35% who remain in NYHA functional class III/ambulatory class IV despite at least 3 months of optimal pharmacological therapy who are expected to survive at least 1 year with good functional status, provided that biventricular pacing as close as possible to 100% can be achieved.	IIa	B
AV junction ablation should be considered in case of incomplete biventricular pacing.	IIa	B

opinion of the experts converges in the following

- 1) LBBB as key underlying conduction disturbance
- 2) a wide QRS complex (>150 ms) as predictor of CRT benefit
- 3) RV pacing-induced LBBB as substrate for poor mechanical function and adverse remodeling.
- 4) Mild heart failure Fc II

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Biventricular Pacing in Patients with Bradycardia and Normal Ejection Fraction

Cheuk-Man Yu, M.D., F.R.C.P., Joseph Yat-Sun Chan, F.H.K.A.M.,
Qing Zhang, M.M., Ph.D., Razali Omar, M.D.,
Gabriel Wai-Kwok Yip, M.D., F.A.C.C., Azlan Hussin, M.D., Fang Fang, Ph.D.,
Kai Huat Lam, M.B., B.S., Hamish Chi-Kin Chan, F.R.C.P.,
and Jeffrey Wing-Hong Fung, M.D., F.R.C.P.

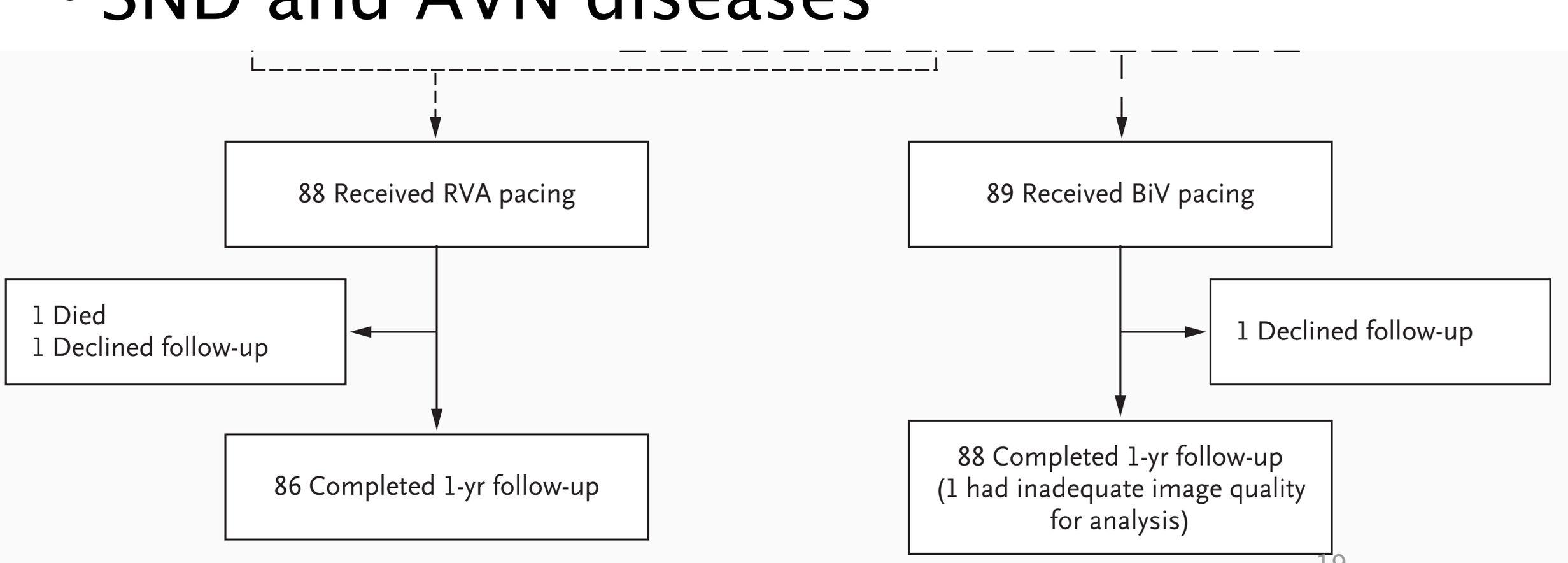
Background

- nonphysiologic right ventricular apical pacing on left ventricular systolic function has been recognized since the 1920s.

- the Dual Chamber and VVI Implantable Defibrillator (DAVID) trial, the unexpected **increased rates of death and hospital admission for heart failure** among patients who were randomly assigned to the dual- chamber, rate-adaptive (DDDR) mode were purportedly due to the adverse effect of right ventricular apical pacing on left ventricular structural remodeling

Patients Population

- a normal left ventricular ejection fraction (45%) and standard indications for pacing
- SND and AVN diseases

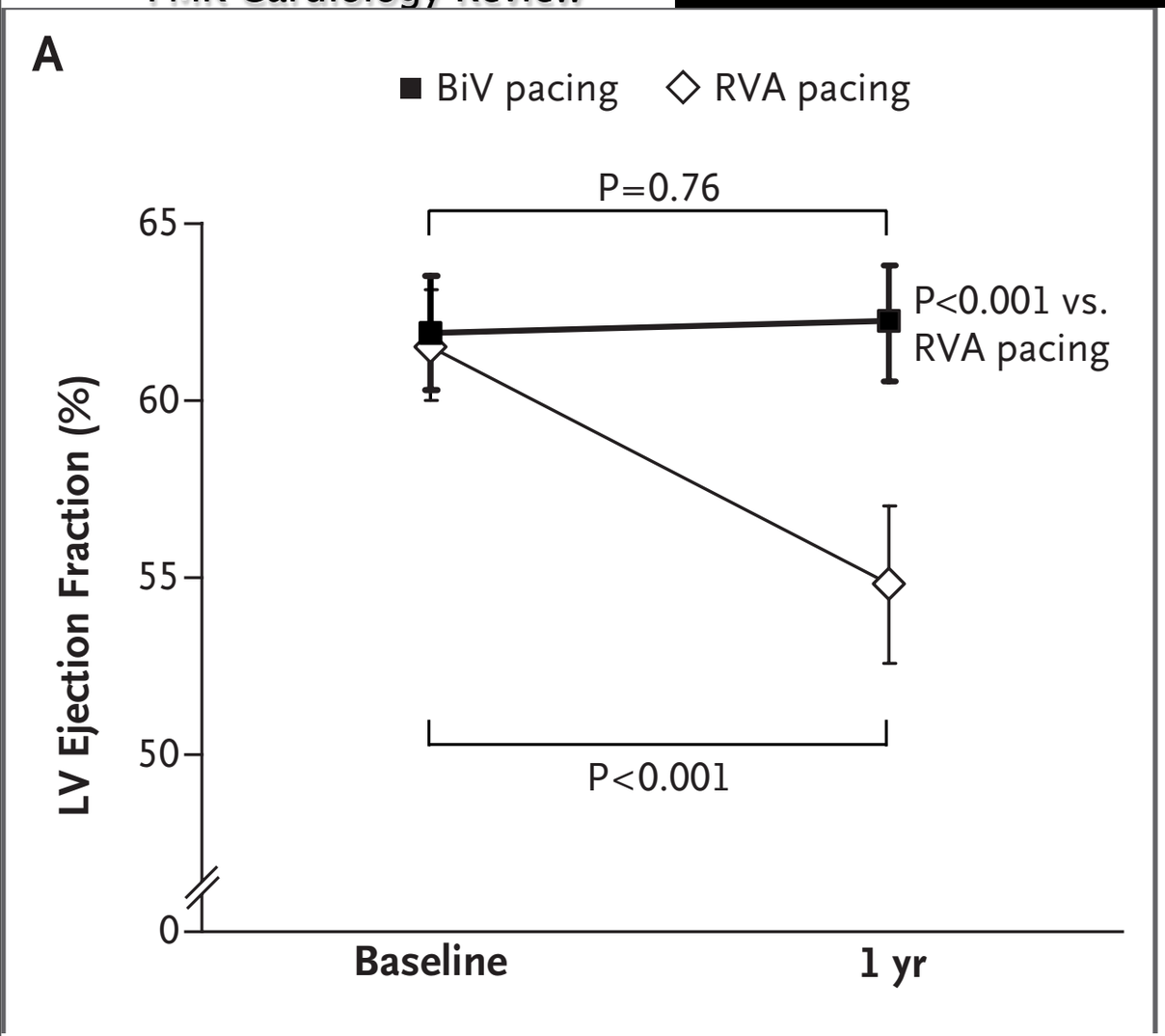


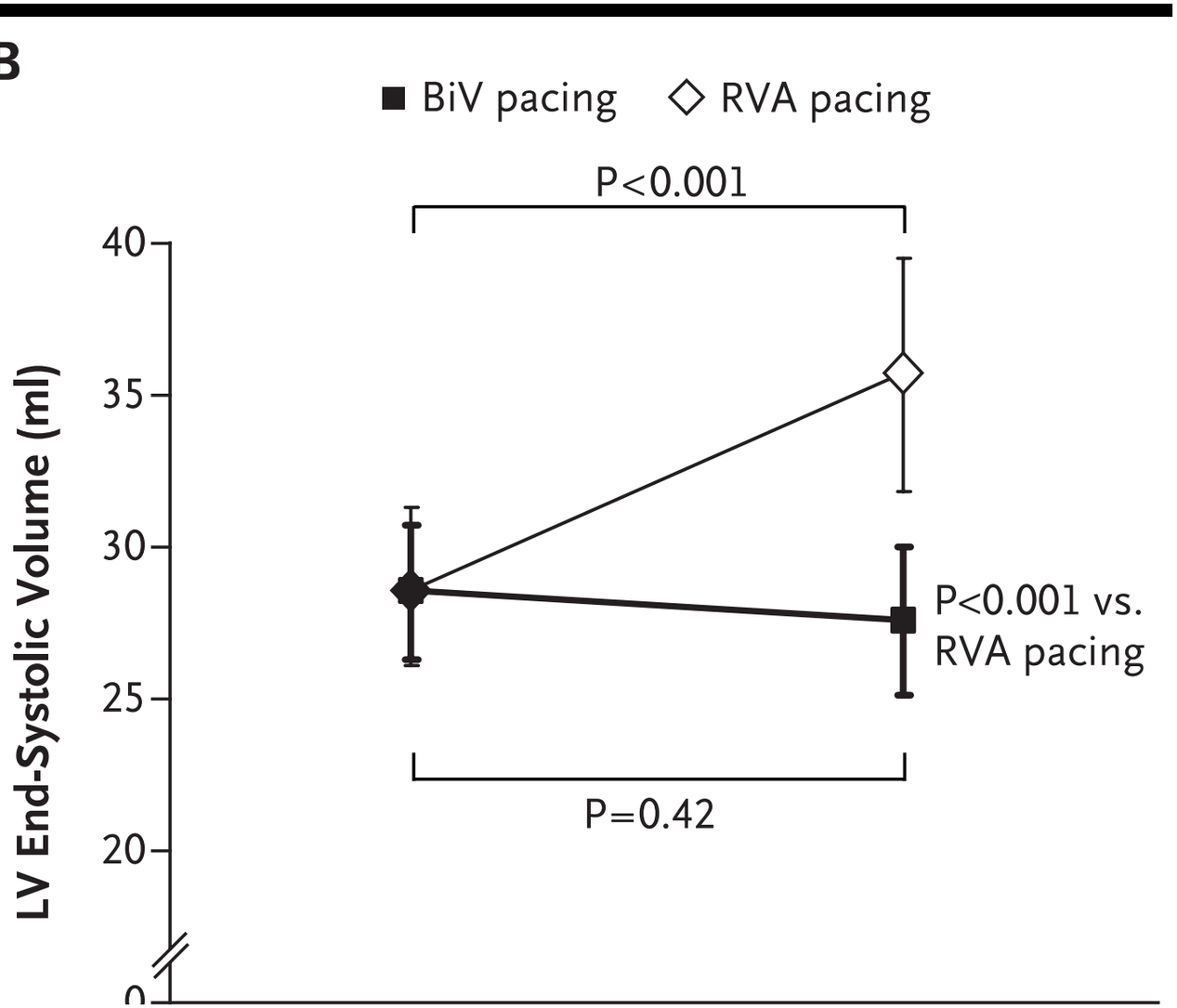
primary end points

- the left ventricular ejection fraction (as an assessment of left ventricular systolic function)

- and left ventricular end-systolic volume (as an assessment of left ventricular remodeling) at 12 months

Echocardiographic data



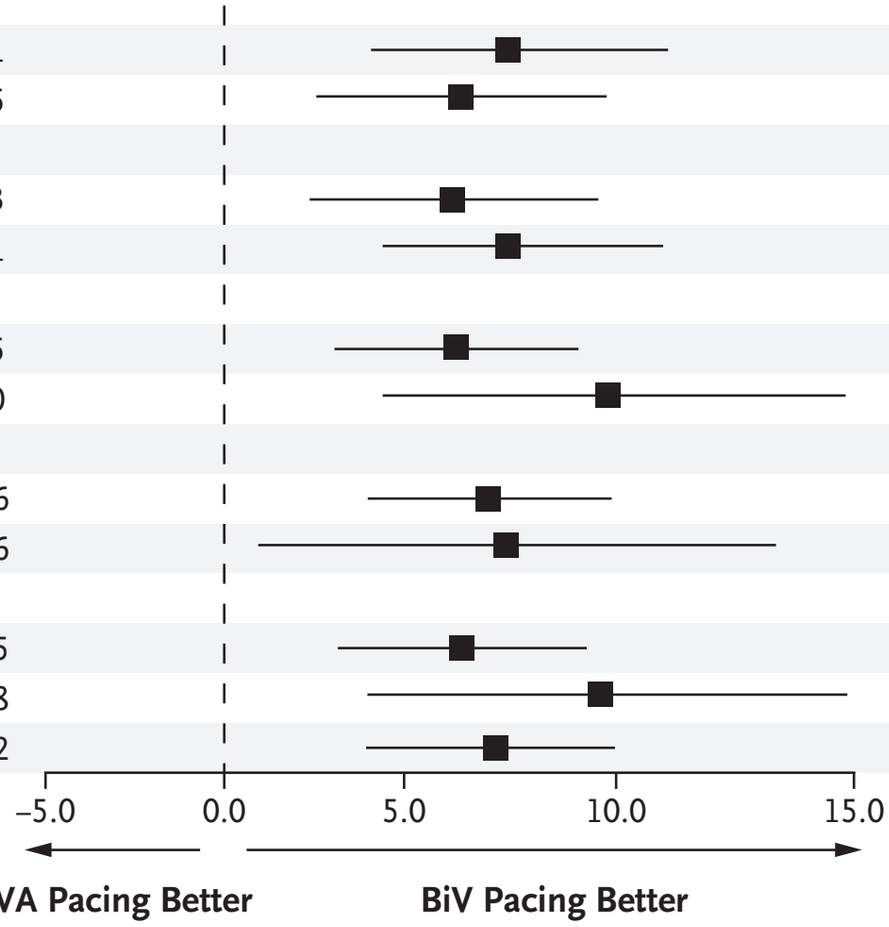


Subgroup Analyses of the Primary End Point of Left Ventricular Ejection Fraction at 12 Months.

PMK

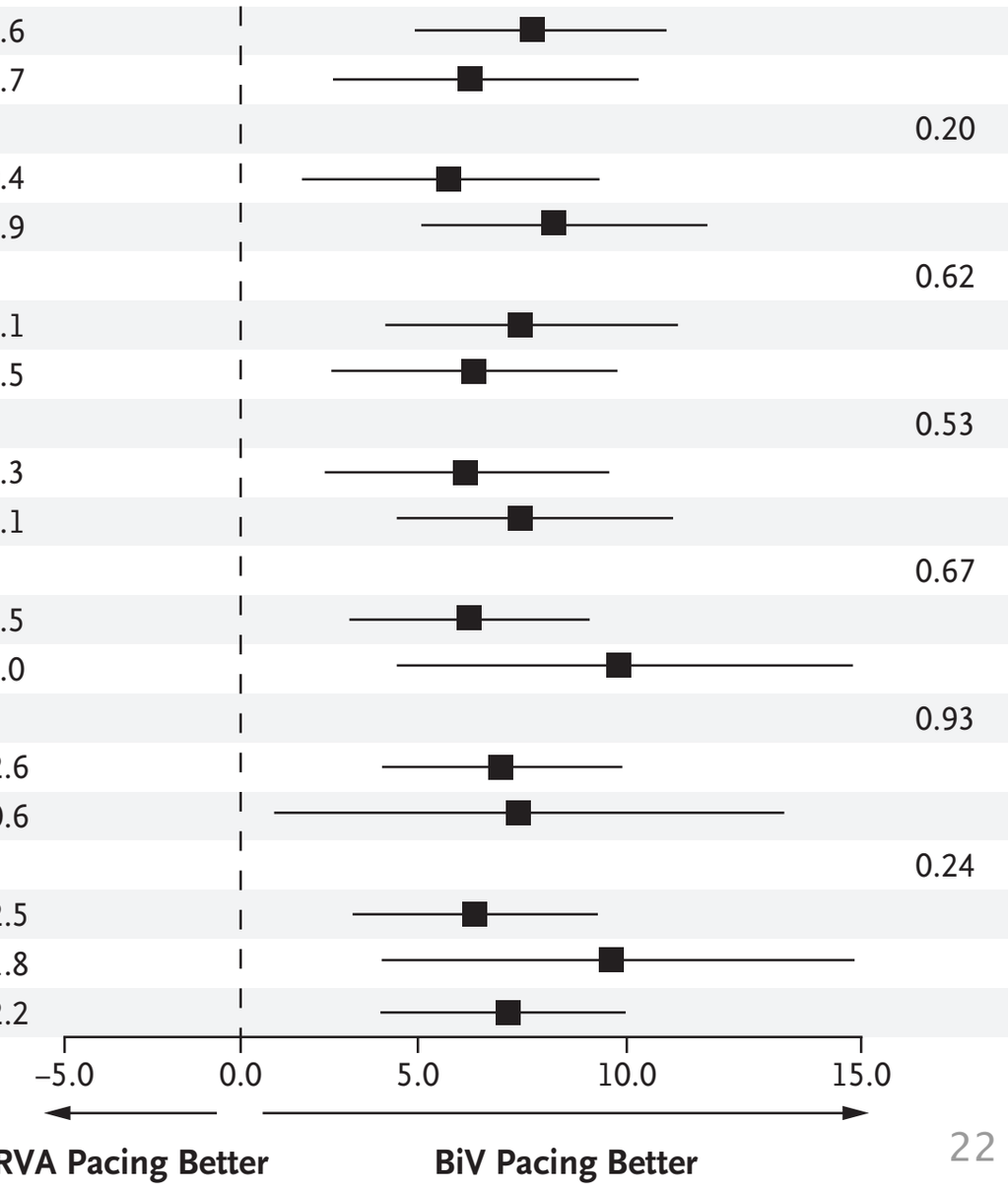
Subgroup	No. of Patients	LV Ejection Fraction (%) RVA	BiV	P Value for Interaction
Diastolic dysfunction				0.46
No	66	54.4	63.1	
Yes	107	55.0	61.6	
Pacing indication				0.53
Heart block	102	54.5	62.6	
Sinus-node dysfunction	71	55.3	61.7	
Age				0.20
<70 yr	86	54.8	60.4	
≥70 yr	87	54.8	63.9	
Sex				0.62
Male	95	53.2	61.1	
Female	78	57.0	63.5	
Hypertension				0.53
No	60	56.1	62.3	
Yes	113	54.0	62.1	
Diabetes				0.67
No	125	56.3	62.5	
Yes	48	51.2	61.0	
Coronary heart disease				0.93
No	135	55.4	62.6	
Yes	38	53.1	60.6	
QRS duration				0.24
<110 msec	113	56.2	62.5	
≥110 msec	60	52.2	61.8	
All patients	173	54.8	62.2	

Difference (percentage points)



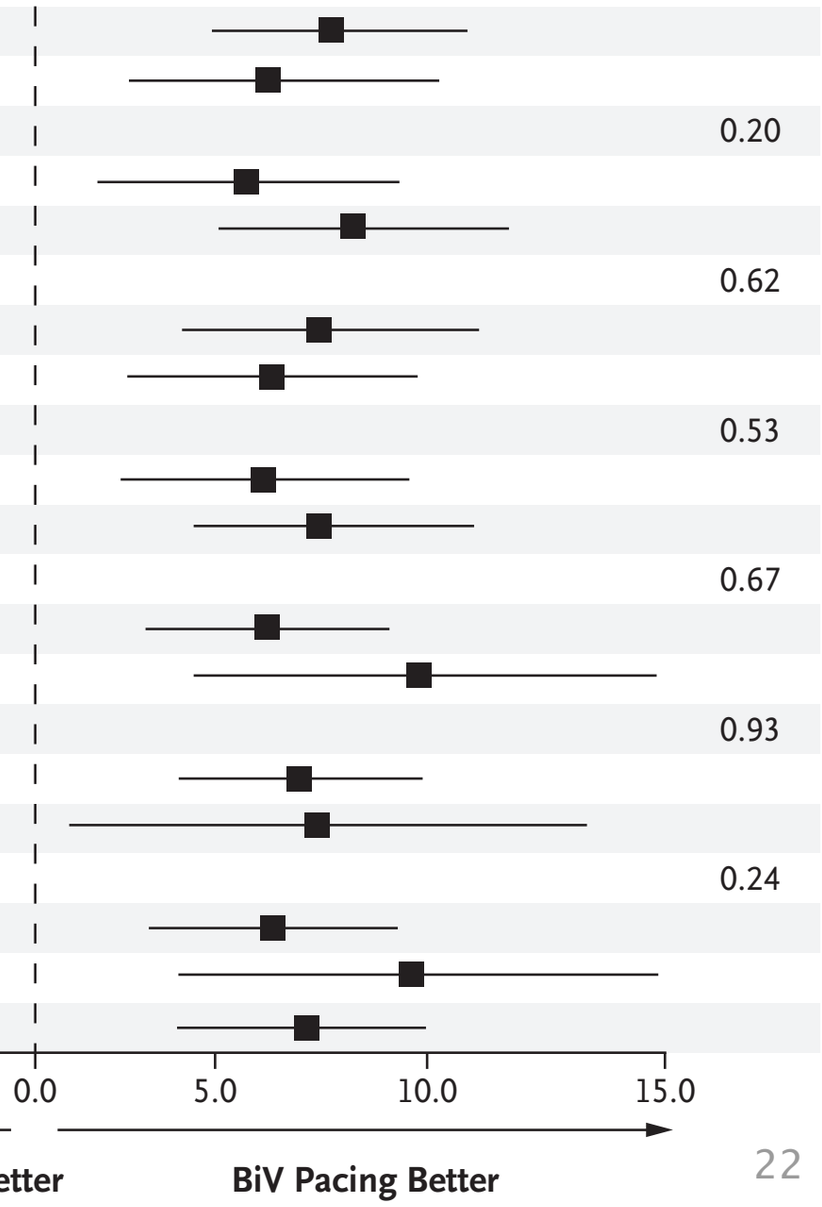
Subgroup Analyses of the Primary End Point of Left Ventricular Ejection Fraction at 12 Months.

Heart block	102	54.5	62.6	
Sinus-node dysfunction	71	55.3	61.7	
Age				0.20
<70 yr	86	54.8	60.4	
≥70 yr	87	54.8	63.9	
Sex				0.62
Male	95	53.2	61.1	
Female	78	57.0	63.5	
Hypertension				0.53
No	60	56.1	62.3	
Yes	113	54.0	62.1	
Diabetes				0.67
No	125	56.3	62.5	
Yes	48	51.2	61.0	
Coronary heart disease				0.93
No	135	55.4	62.6	
Yes	38	53.1	60.6	
QRS duration				0.24
<110 msec	113	56.2	62.5	
≥110 msec	60	52.2	61.8	
All patients	173	54.8	62.2	



Subgroup Analyses of the Primary End Point of Left Ventricular Ejection Fraction at 12 Months.

Pacing indication			
Heart block	102	54.5	62.6
Sinus-node dysfunction	71	55.3	61.7
Age			
<70 yr	86	54.8	60.4
≥70 yr	87	54.8	63.9
Sex			
Male	95	53.2	61.1
Female	78	57.0	63.5
Hypertension			
No	60	56.1	62.3
Yes	113	54.0	62.1
Diabetes			
No	125	56.3	62.5
Yes	48	51.2	61.0
Coronary heart disease			
No	135	55.4	62.6
Yes	38	53.1	60.6
QRS duration			
<110 msec	113	56.2	62.5
≥110 msec	60	52.2	61.8
All patients	173	54.8	62.2



Conclusions

- In patients with normal systolic function, conventional right ventricular apical pacing resulted in adverse left ventricular remodeling and in a reduction in the left ventricular ejection fraction

- these effects were prevented by biventricular pacing

ORIGINAL ARTICLE

Biventricular Pacing for Atrioventricular Block and Systolic Dysfunction

Anne B. Curtis, M.D., Seth J. Worley, M.D., Philip B. Adamson, M.D., Eugene S. Chung, M.D., Imran Niazi, M.D., Lou Sherfesee, Ph.D., Timothy Shinn, M.D., and Martin St. John Sutton, M.D., for the Biventricular versus Right Ventricular Pacing in Heart Failure Patients with Atrioventricular Block (BLOCK HF) Trial Investigators

Pacing and CRT

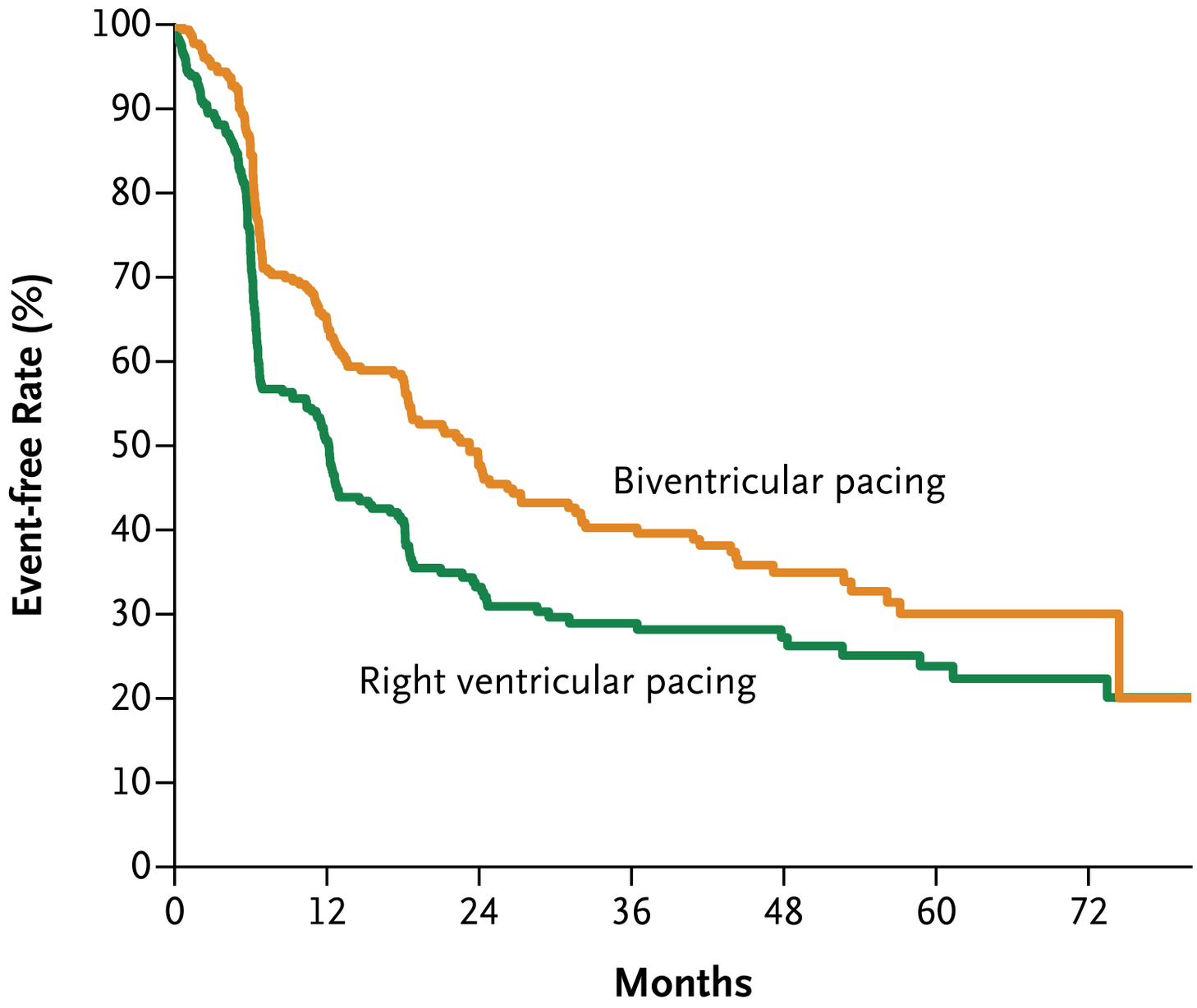
ORIGINAL ARTICLE

- standard class I or IIa indication for a pacemaker owing to high-degree atrioventricular block and
-who also had New York Heart Association (NYHA) class I, II, or III symptoms of heart failure and
-left ventricular ejection fraction of 50% or less

OUTCOME MEASURES

- The primary outcome was
- 1.the time to a first event of death from any cause,
- 2. an urgent care visit for heart failure that required intravenous therapy,
- 3. an increase in the left ventricular end-systolic volume index of 15% or more

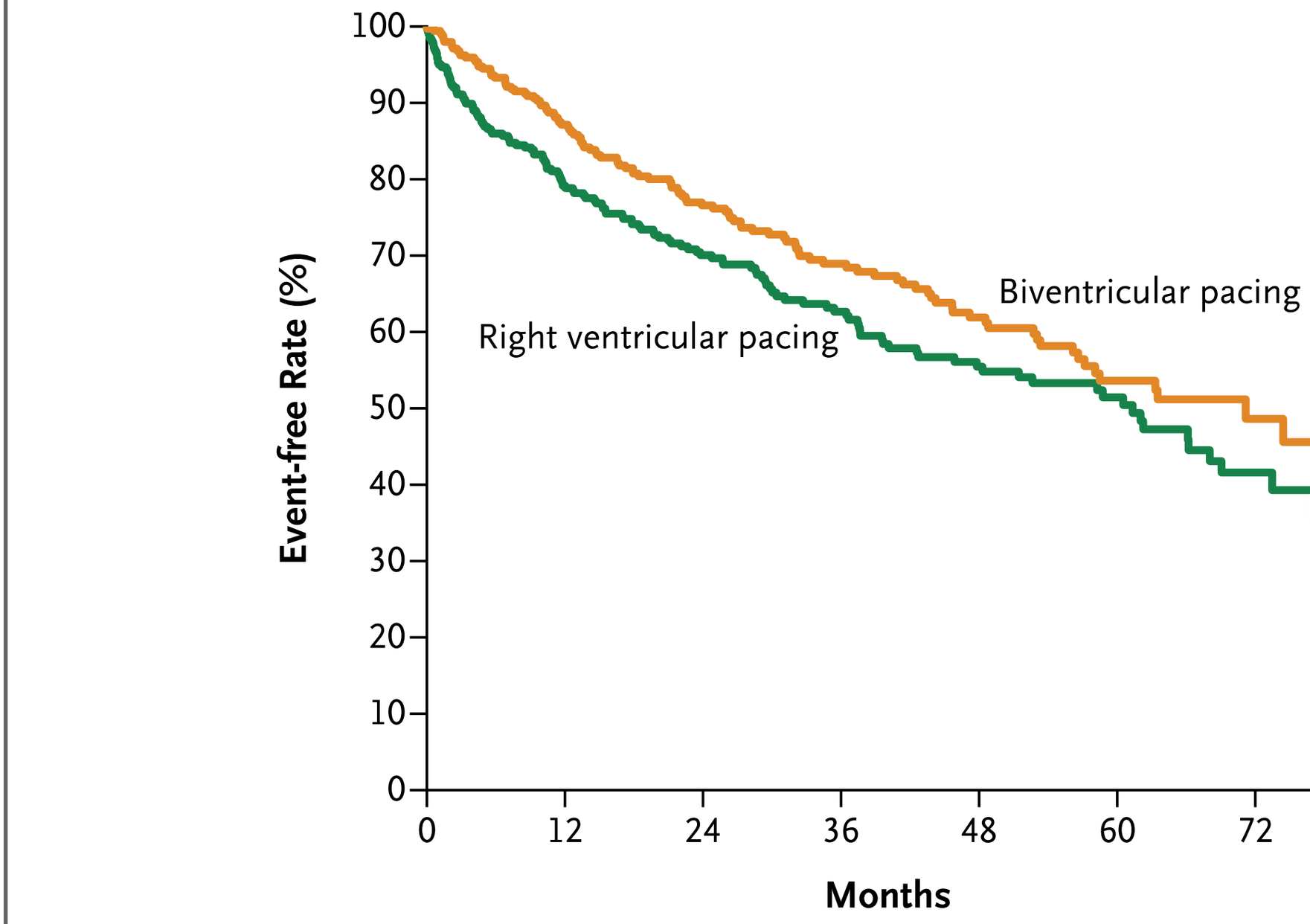
Freedom from a Primary-Outcome Event.



No. at Risk

Biventricular pacing	349	161	87	62	38	17	3
Right ventricular pacing	342	126	59	39	28	18	10

Freedom from the Clinical Components of the Primary Outcome.



No. at Risk

Biventricular pacing	349	271	195	134	91	52	17	27
Right ventricular	342	248	180	121	88	54	22	

Conclusions

- biventricular pacing provides superior ventricular- rate support,

- as compared with traditional right ventricular apical pacing, in patients with atrioventricular block, mild-to-moderate heart failure, and abnormal left ventricular systolic function.

Secondary prevention

Recommendations	Class[a]	Level[b]
ICD implantation is recommended in patients with documented VF or haemodynamically not tolerated VT in the absence of reversible causes or within 48 h after myocardial infarction who are receiving chronic optimal medical therapy and have a reasonable expectation of survival with a good functional status >1 year.	I	A
ICD implantation should be considered in patients with recurrent sustained VT (not within 48 h after myocardial infarction) who are receiving chronic optimal medical therapy, have a normal LVEF and have a reasonable expectation of survival with good functional status for >1 year.	IIa	C
In patients with VF/VT and an indication for ICD, amiodarone may be considered when an ICD is not available, contraindicated for concurrent medical reasons or refused by the patient.	IIb	C

Primary Prevention

Recommendations	Class[a]	Level[b]	Ref.[c]
ICD therapy is recommended to reduce SCD in patients with symptomatic HF (NYHA class II–III) and LVEF ≤35% after ≥3 months of optimal medical therapy who are expected to survive for at least 1 year with good functional status:			
– Ischaemic aetiology (at least 6 weeks after myocardial infarction).	I	A	
– Non-ischaemic aetiology.	I	B	

Asymptomatic

- Currently there are no RCTs demonstrating the value of an ICD in asymptomatic patients (NYHA class I) with systolic dysfunction (LVEF ≤35-40%)

CRTD 2015

Recommendations	Class[b]	Level[c]
CRT-D is recommended to reduce all-cause mortality in patients with a QRS duration ≥130 ms, with an LVEF ≤30% and with LBBB despite at least 3 months of optimal pharmacological therapy who are expected to survive at least 1 year with good functional status.	I	A
CRT-D may be considered to prevent hospitalization for HF in patients with a QRS duration ≥150 ms, irrespective of QRS morphology, and an LVEF ≤35% despite at least 3 months of optimal pharmacological therapy who are expected to survive at least 1 year with good functional status.	IIb	A

Conclusions

- biventricular pacing provides superior ventricular- rate support, as compared with traditional right ventricular apical pacing,
  - in patients with atrioventricular block,
  - -mild-to-moderate heart failure,
  - -and abnormal left ventricular systolic function

Complications

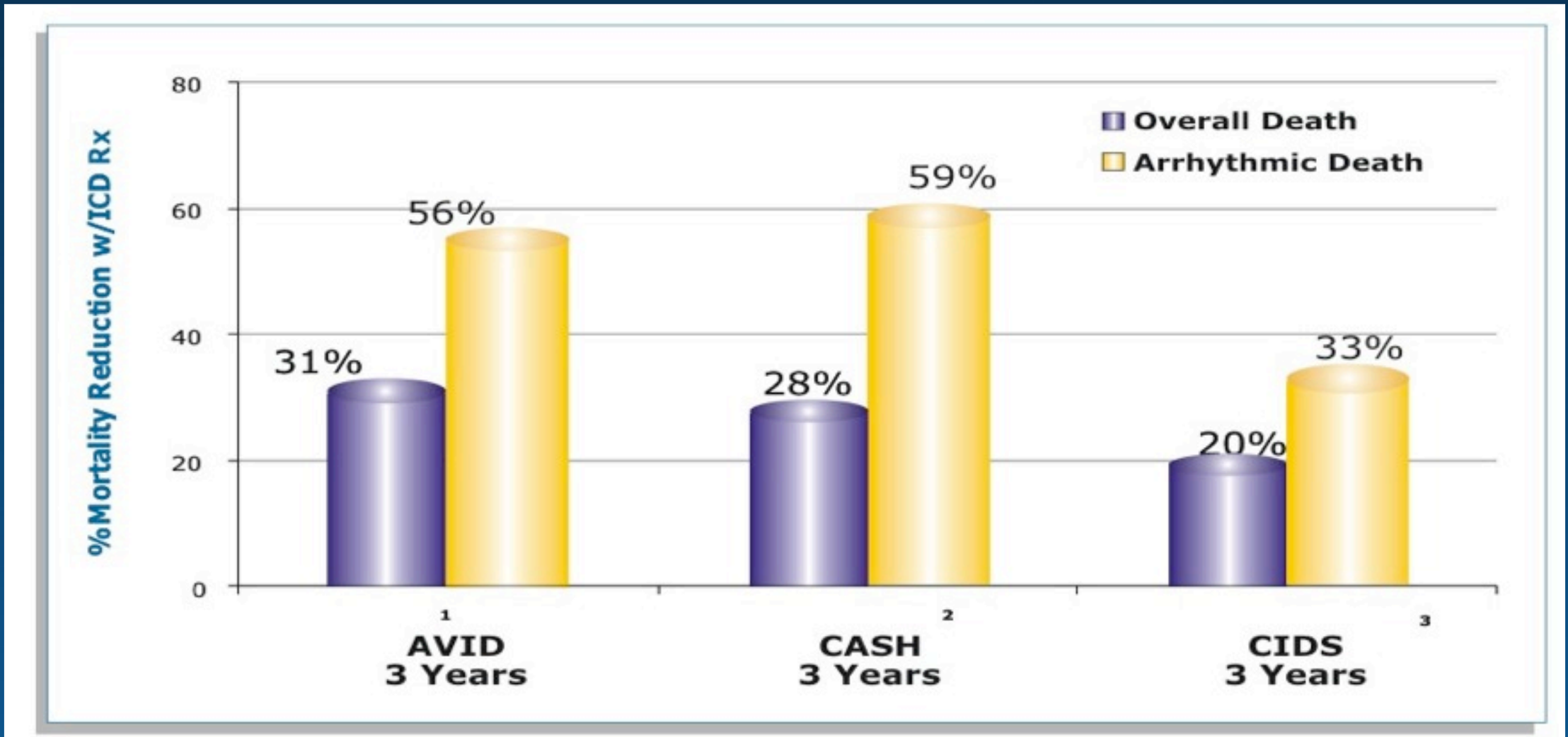
- pneumothorax (1.7% in the CRT-ICD group and 0.8% in the ICD-only group),

- infection (1.1% in the CRT-ICD group and 0.7% in the ICD-only group),

- and pocket hematoma requiring evacuation (3.3% in the CRT-ICD group and 2.5% in the ICD-only group).

- coronary venous dissection with pericardial effusion occurred in 5 patients (0.5%),

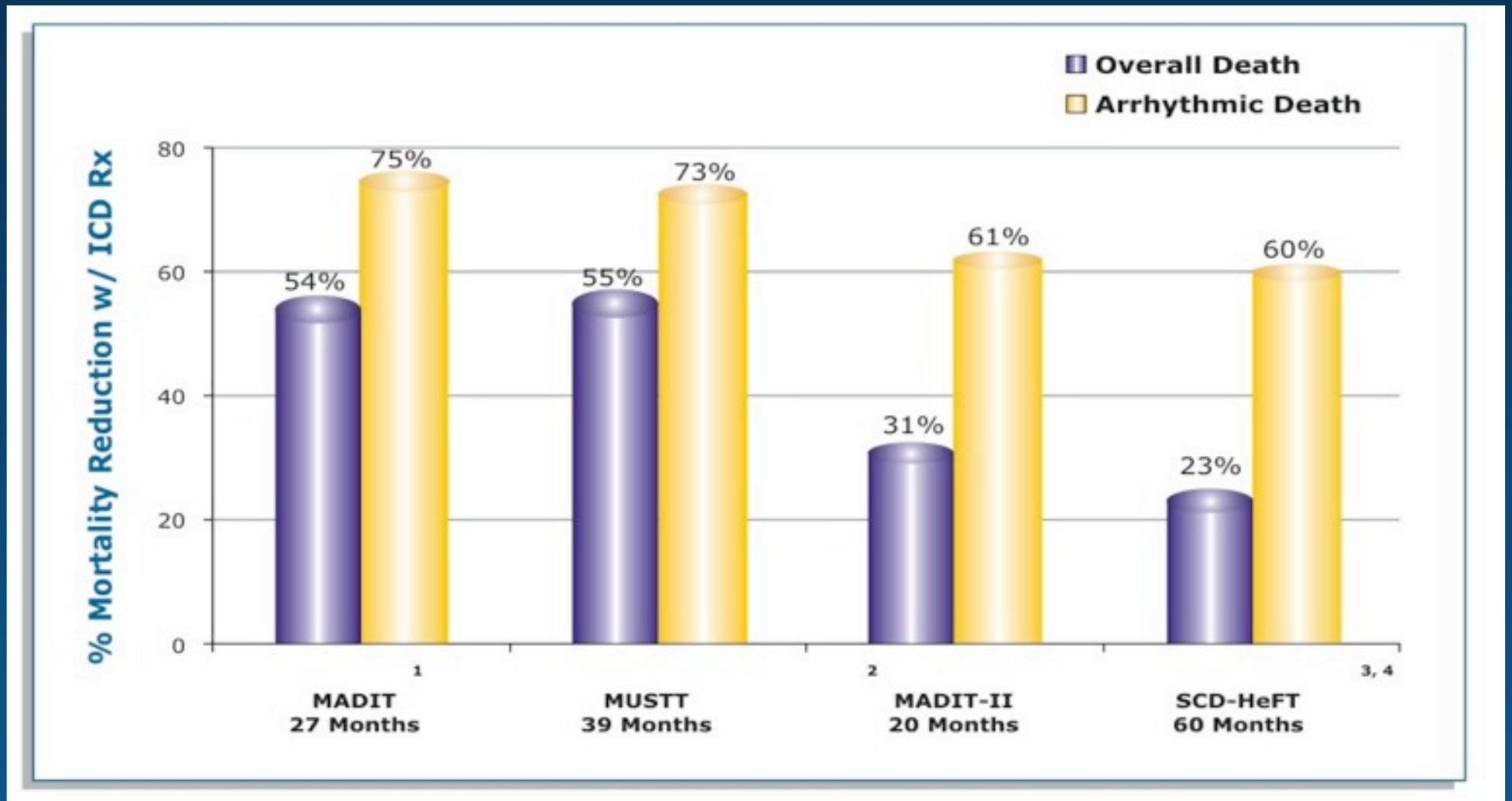
ICD: significantly reduces mortality compared to anti-arrhythmic drugs in highest risk VT/VF patients



Drugs have a limited role in reducing death due to SCA in highest risk VT/VF patients

The AVID Investigators. N Engl J Med. 1997;337:1576-83.
Kuck K. *Circ.2000;102:748-54.*
Connolly S. *Circ*. 2000;101:1297-1302.

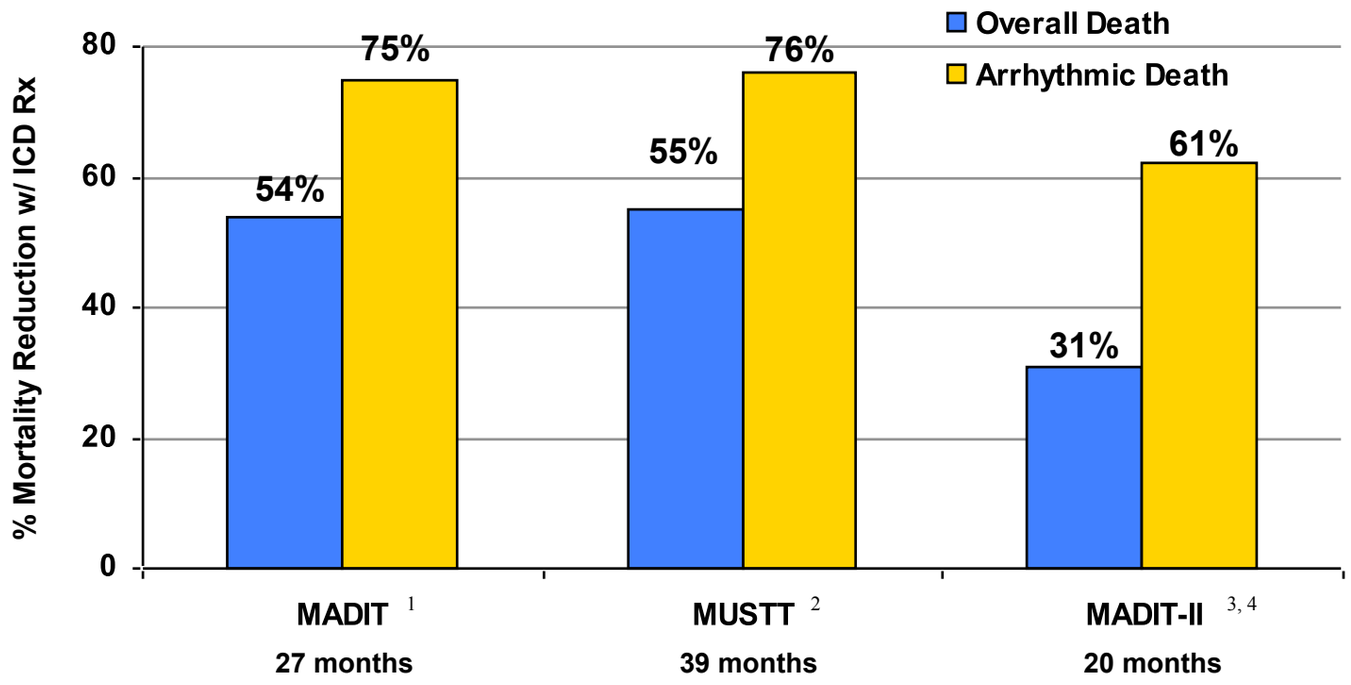
ICD: significantly reduces mortality compared to anti-arrhythmic drugs in high risk post MI, low EF patients

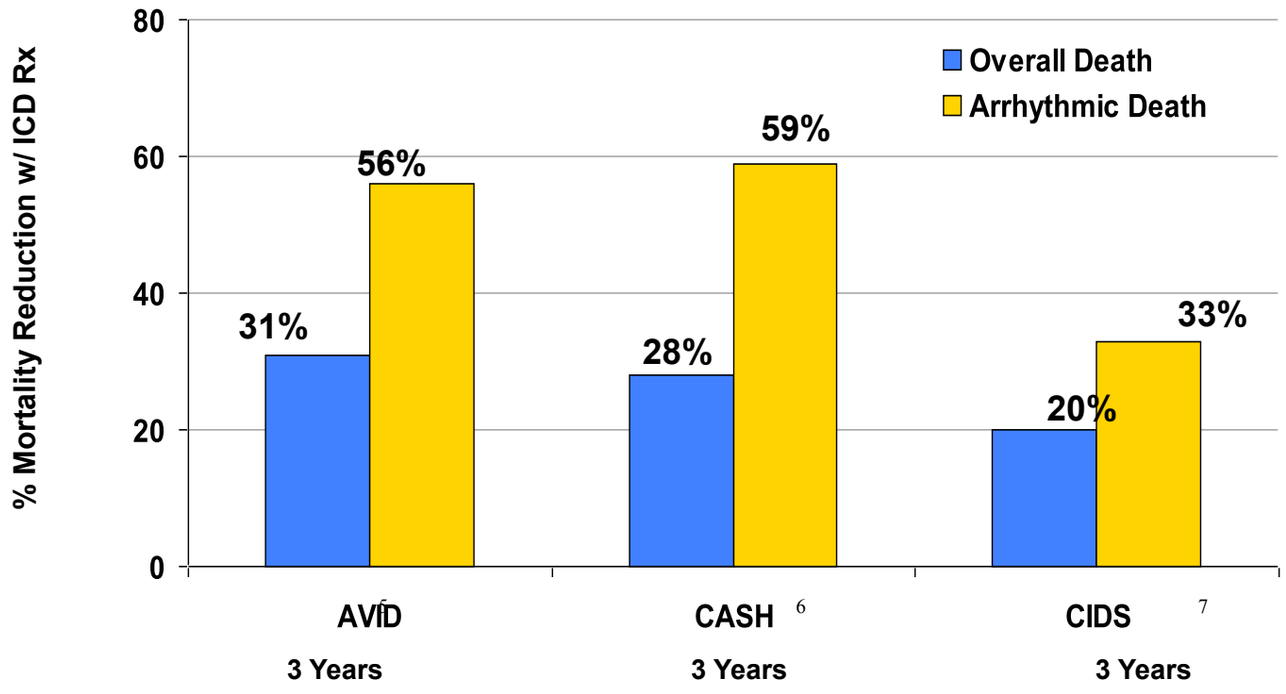


Drugs have a limited role in reducing death due to SCA in HF patients & post MI, low EF patients

Moss AJ. *N Engl J Med*. 1996;335:1933-40.
Buxton AE. *N Engl J Med.* 1999;341:1882-90.
Moss AF. *N Engl J Med.* 2002;346:877-83.
Moss AJ. Presented before ACC 51st Annual Scientific Sessions, Late Breaking Clinical Trials, March 19, 2002.
Bardy et al N Eng J Med 2005; 352: 225-237

Reductions in Mortality with ICD Therapy





ICD mortality reductions in primary prevention trials <u>are equal to or greater</u> than those in secondary prevention trials.

[1] Moss AJ. *N Engl J Med*. 1996;335:1933-40.

[2] Buxton AE. *N Engl J Med*. 1999;341:1882-90.

[3] Moss AJ. *N Engl J Med*. 2002;346:877-83

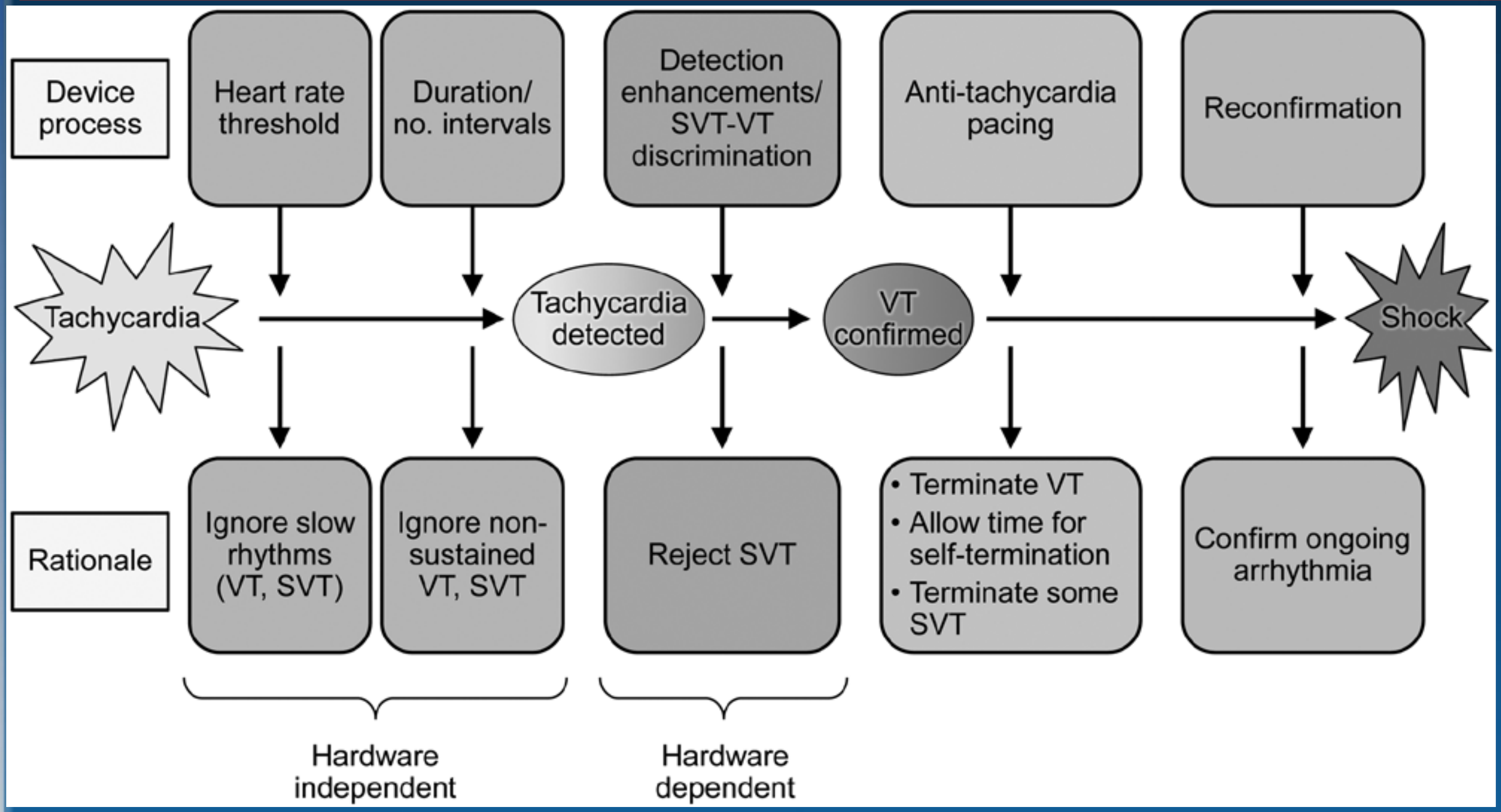
[4] Moss AJ. Presented before ACC 51st Annual Scientific Sessions, Late Breaking Clinical Trials, March 19, 2002.

[5] The AVID Investigators. *N Engl J Med*. 1997;337:1576-83.

[6] Kuck K. *Circ*. 2000;102:748-54.

[7] Connolly S. Circ. 2000:101:1297-1302.

Strategies For Shock Reduction



Secondary prevention

Recommendations	Class[a]	Level[b]
ICD implantation is recommended in patients with documented VF or haemodynamically not tolerated VT in the absence of reversible causes or within 48 h after myocardial infarction who are receiving chronic optimal medical therapy and have a reasonable expectation of survival with a good functional status >1 year.	I	A
ICD implantation should be considered in patients with recurrent sustained VT (not within 48 h after myocardial infarction) who are receiving chronic optimal medical therapy, have a normal LVEF and have a reasonable expectation of survival with good functional status for >1 year.	IIa	C
In patients with VF/VT and an indication for ICD, amiodarone may be considered when an ICD is not available, contraindicated for concurrent medical reasons or refused by the patient.	IIb	C

Primary Prevention

Recommendations	Class[a]	Level[b]	Ref.[c]
ICD therapy is recommended to reduce SCD in patients with symptomatic HF (NYHA class II–III) and LVEF ≤35% after ≥3 months of optimal medical therapy who are expected to survive for at least 1 year with good functional status:			
– Ischaemic aetiology (at least 6 weeks after myocardial infarction).	I	A	
– Non-ischaemic aetiology.	I	B	

Asymptomatic

- Currently there are no RCTs demonstrating the value of an ICD in asymptomatic patients (NYHA class I) with systolic dysfunction (LVEF ≤35-40%)

CRTD 2015

Recommendations	Class[b]	Level[c]
CRT-D is recommended to reduce all-cause mortality in patients with a QRS duration ≥130 ms, with an LVEF ≤30% and with LBBB despite at least 3 months of optimal pharmacological therapy who are expected to survive at least 1 year with good functional status.	I	A
CRT-D may be considered to prevent hospitalization for HF in patients with a QRS duration ≥150 ms, irrespective of QRS morphology, and an LVEF ≤35% despite at least 3 months of optimal pharmacological therapy who are expected to survive at least 1 year with good functional status.	IIb	A

New(Standard)Technology

- Optival Fluid measurement

- Adaptive LV pacing

Scope of presentation

- Natural history of heart failure
- Primary and secondary prevention
- ICD and its indication
- CRT and its indication