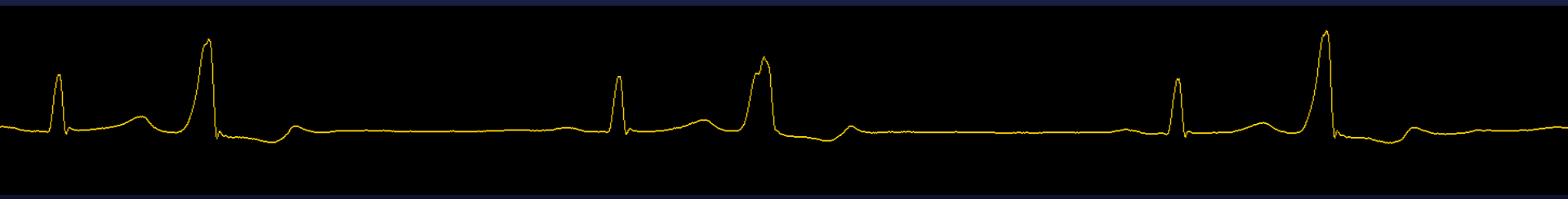
KHRS 2019

Premature Ventricular Contraction-Induced Cardiomyopathy



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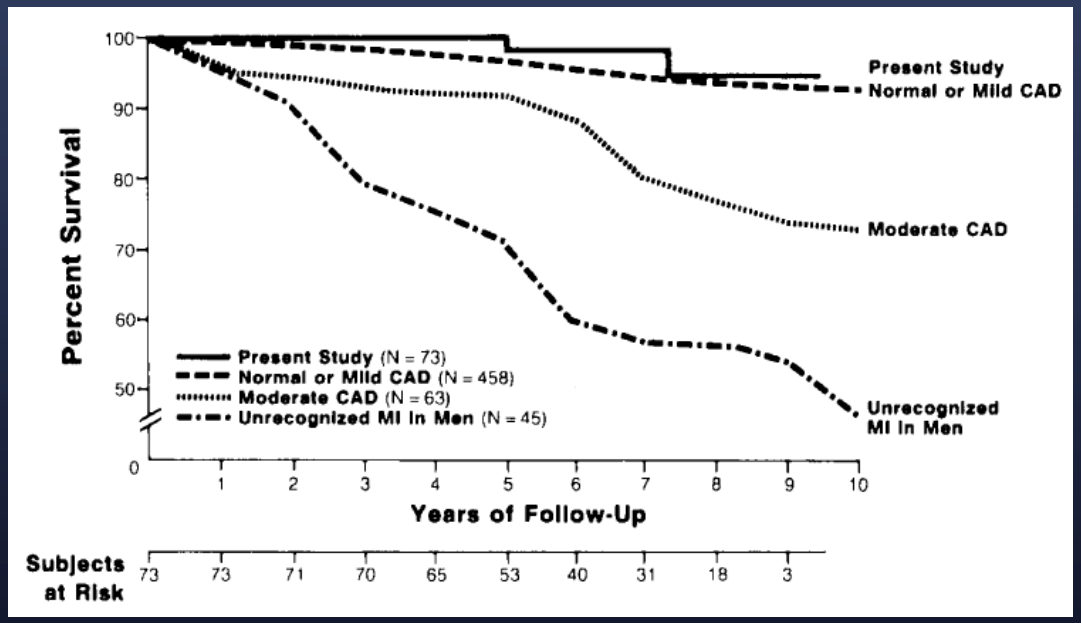
Some light on the subject

- Observational studies in healthy subjects - 1970s to 1990s
  - ~10% of subjects will have "frequent" PVCs (>100/24h or 0.1% PVCs)
  - >1% PVCs is rare
  - Athletes tend to have a higher rate of PVCs

Generally a good prognosis



Kennedy HL et al. NEJM. 1985; 312(4): 193.
Kostis JB et al. Circulation. 1981; 63(3): 1351.
Biffi A et al. JACC. 2002; 40(3): 446.

Original Article

mayo

Suppression of Frequent Premature Ventricular Contractions and Improvement of Left Ventricular Function in Patients With Presumed Idiopathic Dilated Cardiomyopathy

DOUGLAS F. DUFFEE, M.D.,* WIN-KUANG SHEN, M.D., AND HUGH C. SMITH, M.D.

Mayo Clin Proc 1998;73:430-433

Are all PVCs benign?

PVC & Symptom

Symptoms caused by PVCs

Palpitations/skipped beats

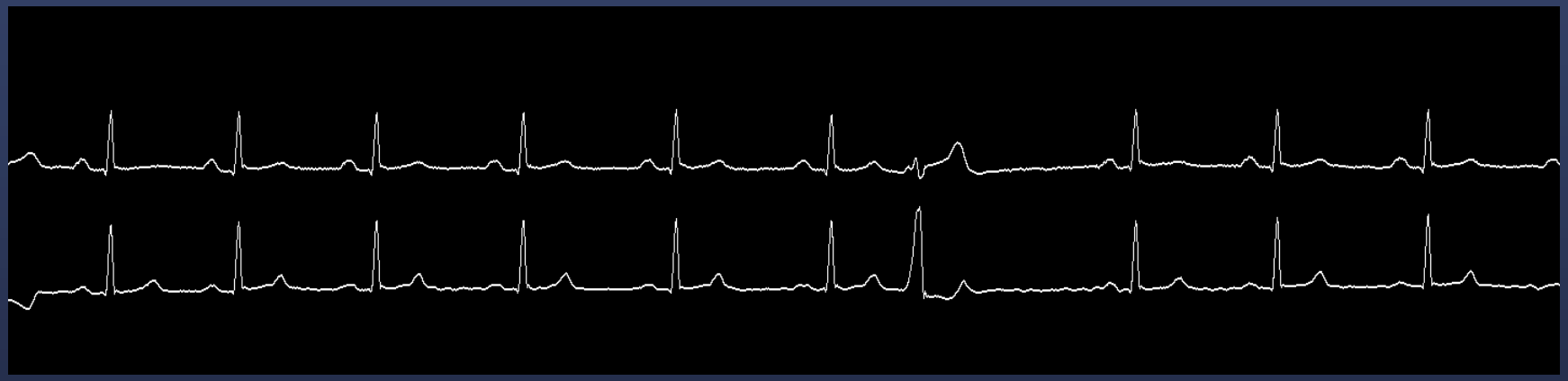
Dizziness

Fatigue

Dyspnea- at rest or on exertion

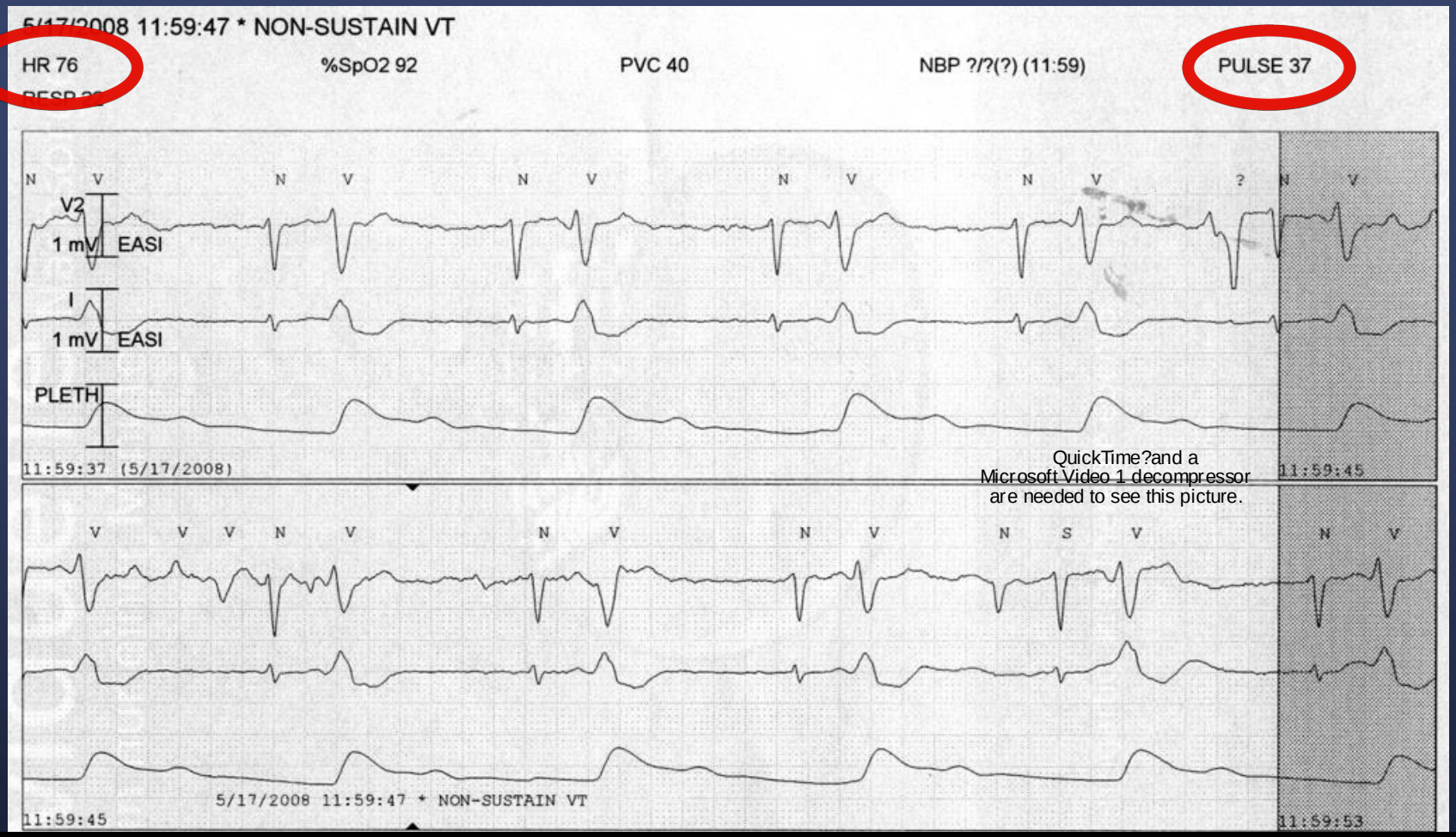
Asymptomatic

Infrequent PVCs - skipped beats



PVC usually not felt

Forceful beat after pause



PVC

HF Symptoms-dizziness, fatigue, dyspnea...

Bradycardia- non perfused PVC

• Asymptomatic PVC

- lack of palpitation is an independent factor prone to developing PVC-induced cardiomyopathy

Blaye-Felice M S et al. Heart Rhythm 2015; 13: 103-10
Munoz et al. J Cardiovasc Electrophysiol 2011;22:791-798
*Hasdemir C et al. J Cardiovasc Electrophysiol 2011;**22**:663-8*
*Yokokawa M et al. Heart Rhythm. 2012;**9**:92-5*
*Deyell MW et al. Heart Rhythm. 2012;**9**:1465-72*

- PVC burden in asymptomatic patients was significantly higher than symptomatic patients

Bogun F et al. Curr Probl cardiol 2015;40:379-422

- It is very reasonable to consider ablating all PVCs, regardless of their origin or associated symptoms when improvement of cardiac function is sought

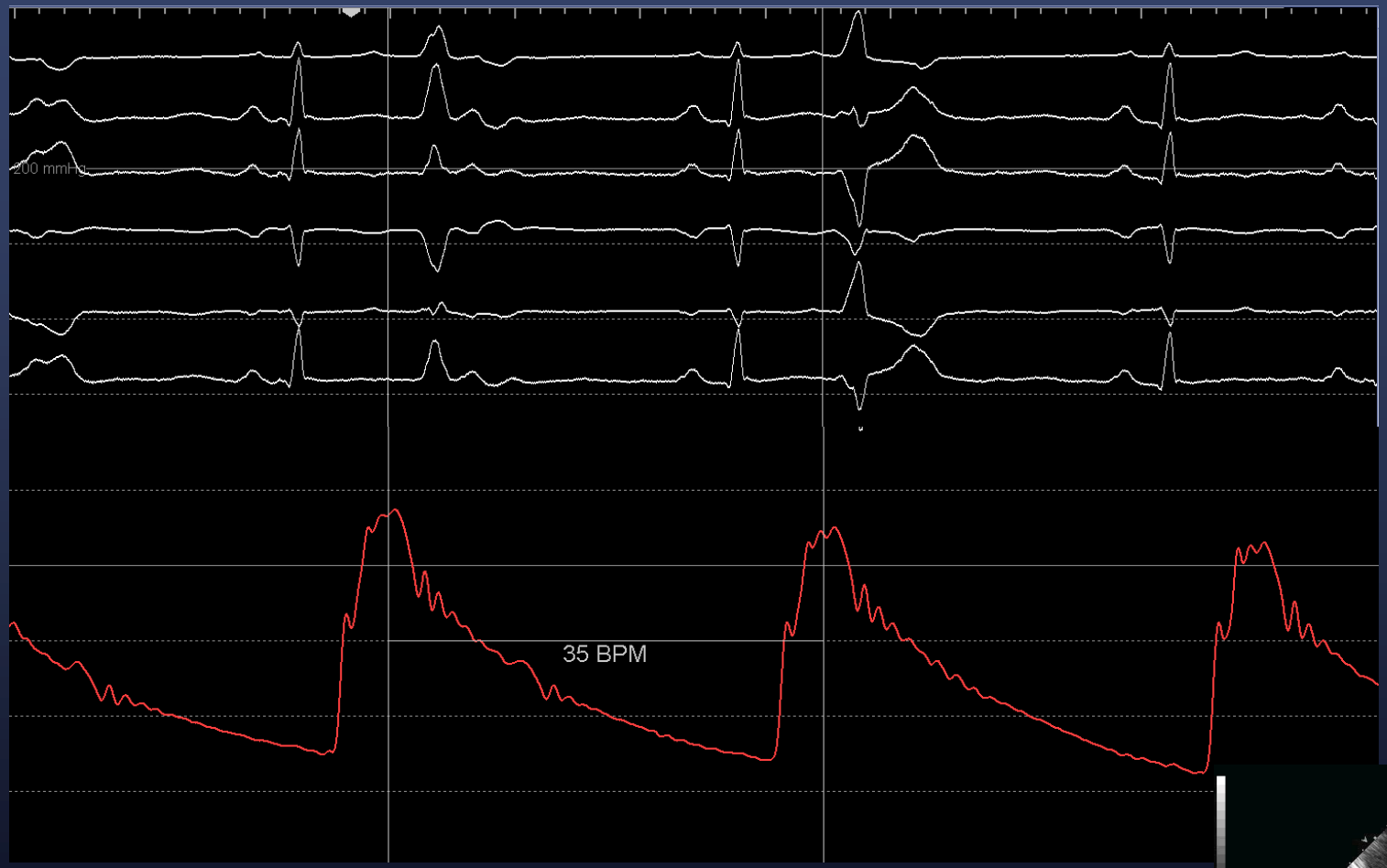
Lu F et al. Am J Cardiol 2012; 110: 852-6

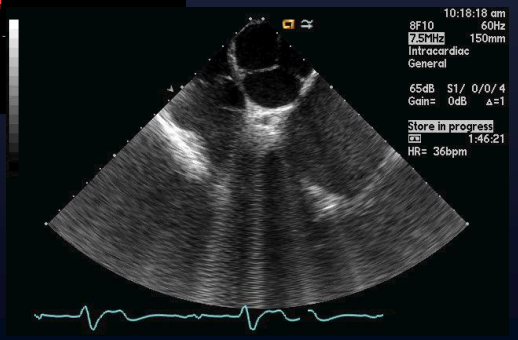
- the absence of typical PVC-related symptoms may be a risk factor for cardiomyopathy and be associated with an adverse outcome.

Park KM et al. Europace. 2016 ;18:881-7

PVC burden

What about frequent PVCs?





Concealed Mechanical Bradycardia

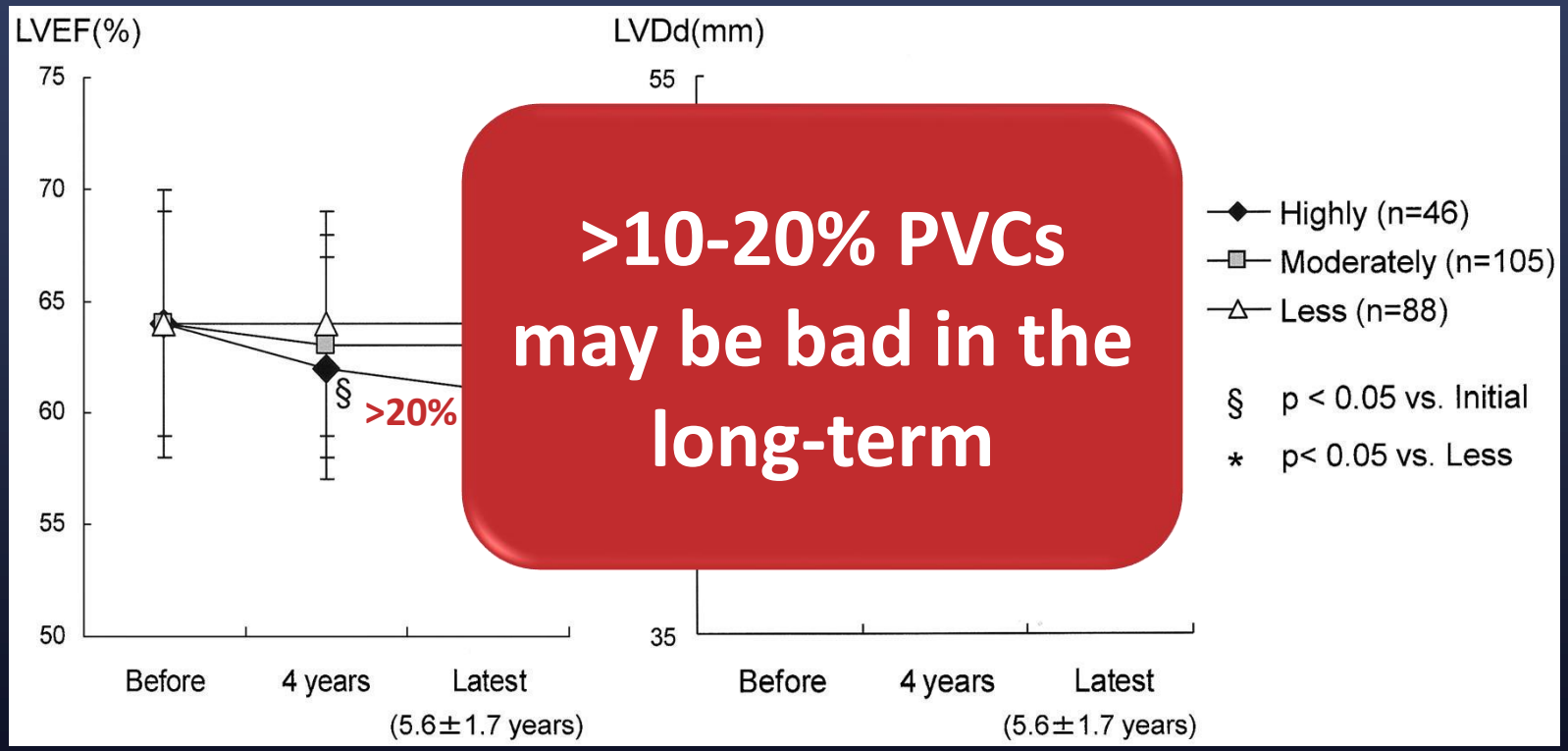
(Electro-mechanical dissociation/pulseless electrical activity)

Deleterious effects of frequent PVCs

- Frequent dysynchronous LV contraction
- Reversed rotational LV squeezing
- Chronic preload strain due to relative bradycardia
- Depletion of myocardial energy storage
- Abnormal calcium handling
- Myocardial ischemia (endo/epi flow mismatch)

Normal LV function + frequent PVCs

- Longitudinal study of 281 patients with frequent, asymptomatic outflow tract PVCs in Japan:



>10-20% PVCs may be bad in the long-term

Niwano S et al. Heart 2009;95:1230-1237

PVC-induced cardiomyopathy

Frequent PVCs → LV dilation and dysfunction

Reversible with elimination of the PVC

Niwano S et al. Heart 2009;95:1230–1237

Hasdemir C et al. J Cardiovasc Electrophysiol 2011;22: 663–668

Takemoto M et al. J Am Coll Cardiol 2005;45:1259–1265

Munoz F et al. J Cardiovasc Electrophysiol 2011;22:791–798

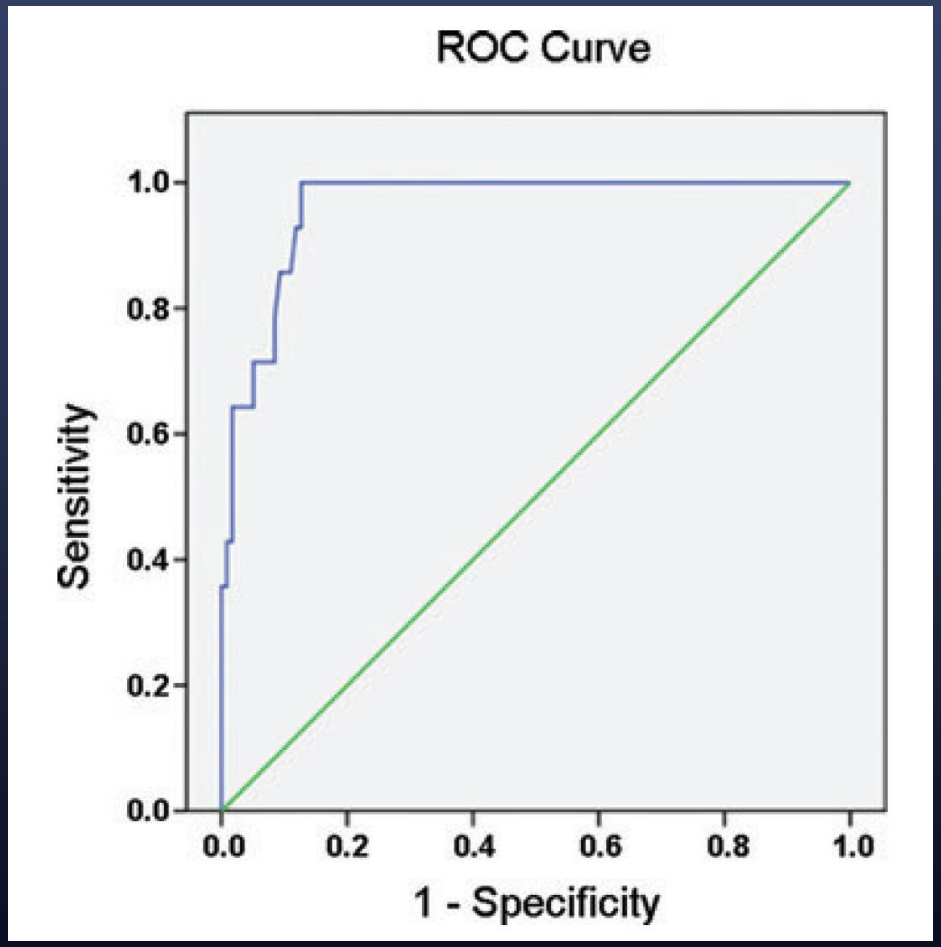
Olgun H et al. Heart Rhythm 2011;8:1046–1049

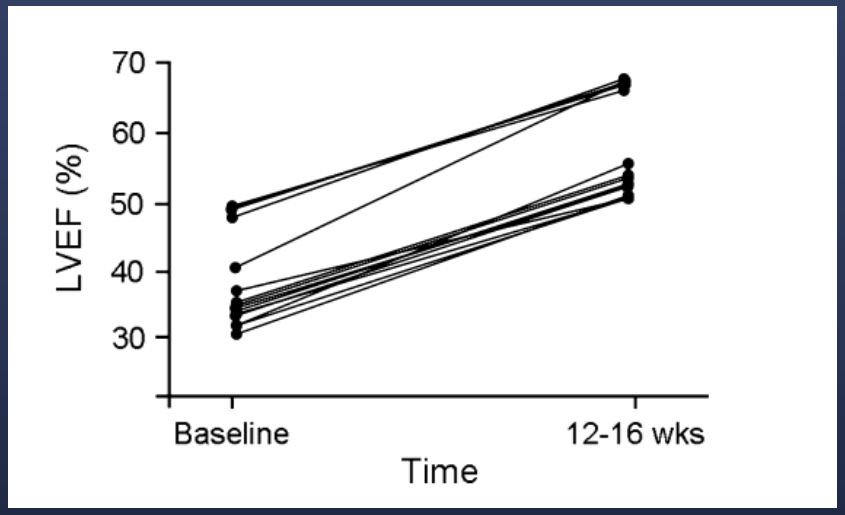
Ban JE et al. Europace 2013;15:735–741

Baman TS et al. Heart Rhythm 2010;7:865–869

Simantirakis EN et al. Europace 2012;14:466–473

Tachycardia-Induced Cardiomyopathy in Patients With Idiopathic Ventricular Arrhythmias: The Incidence, Clinical and Electrophysiologic Characteristics, and the Predictors

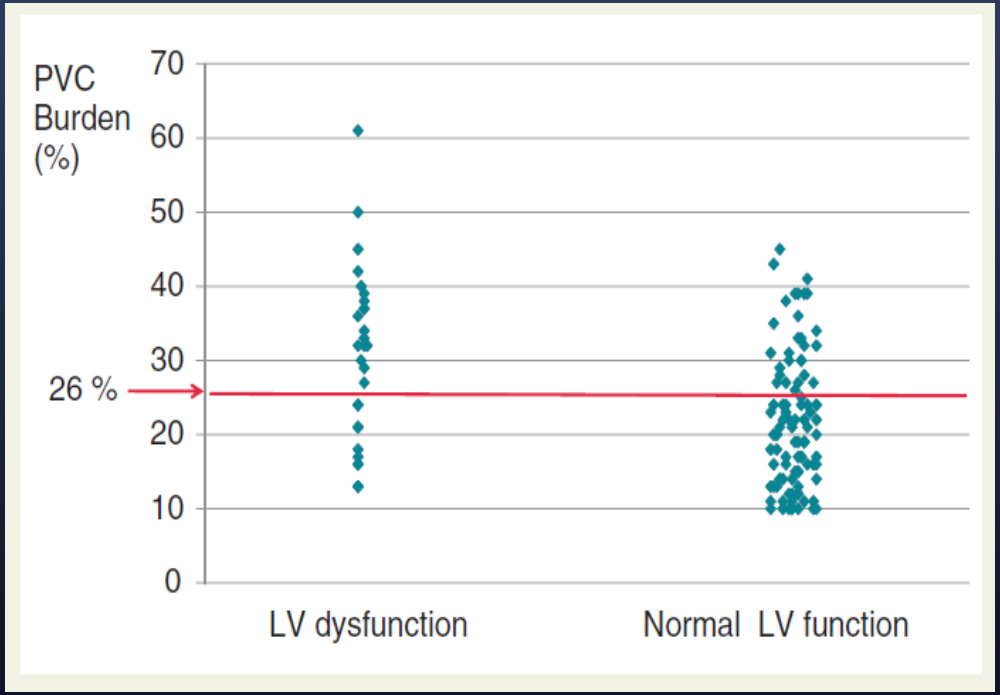




- **PVC burden > 16%** (Sensitivity 100%, Specificity 87%, AUC 0.96)

Hasdemir C et al. J Cardiovasc Electrophysiol 2011; 22: 663-668.

Electrocardiographic and electrophysiological characteristics of premature ventricular complexes associated with left ventricular dysfunction in patients without structural heart disease

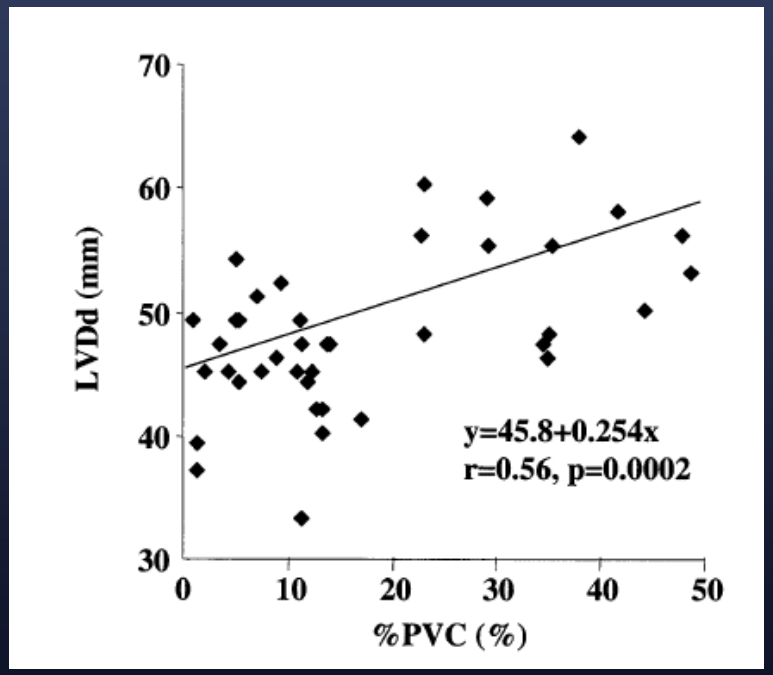


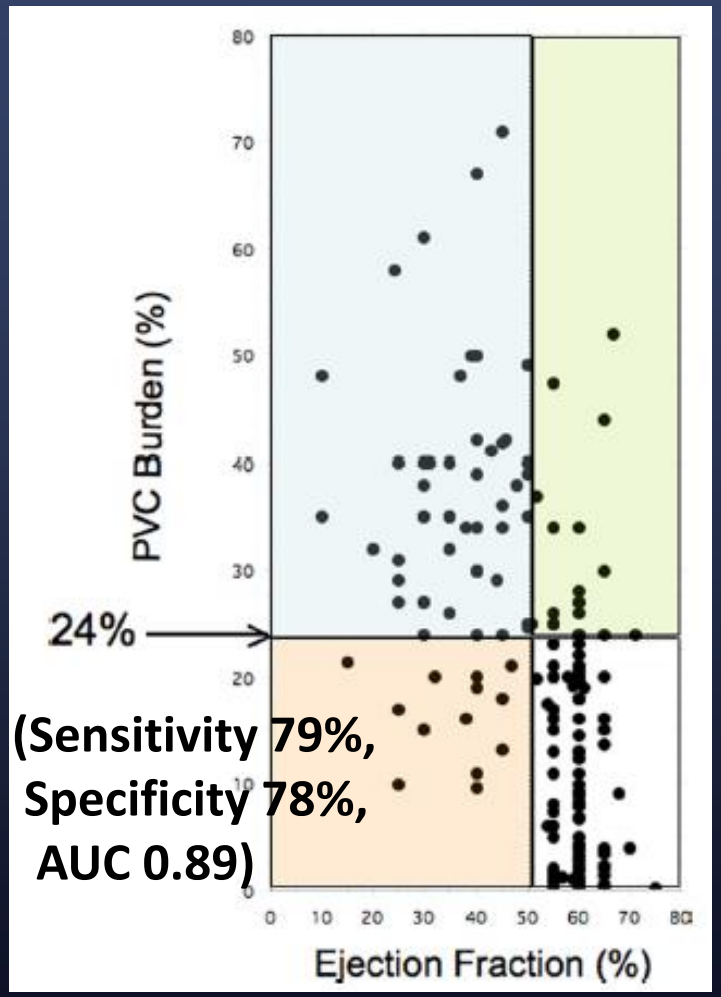
PVC burden > 26%
(Sensitivity 70%,
Specificity 78%)

Ban JE et al. Europace 2013; 15: 735-741.

Normal LV function + frequent PVCs

Is there a dose response relationship?





Takemoto M et al. JACC. 2005; 45: 1259.
Baman T et al. Heart Rhythm. 2010; 7: 865.

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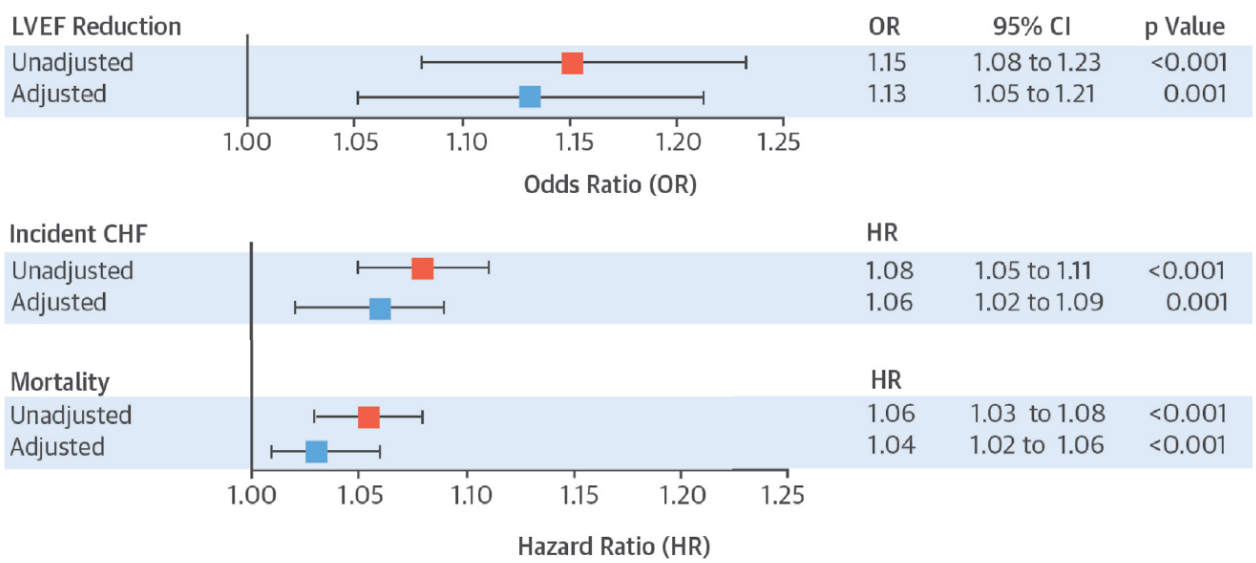
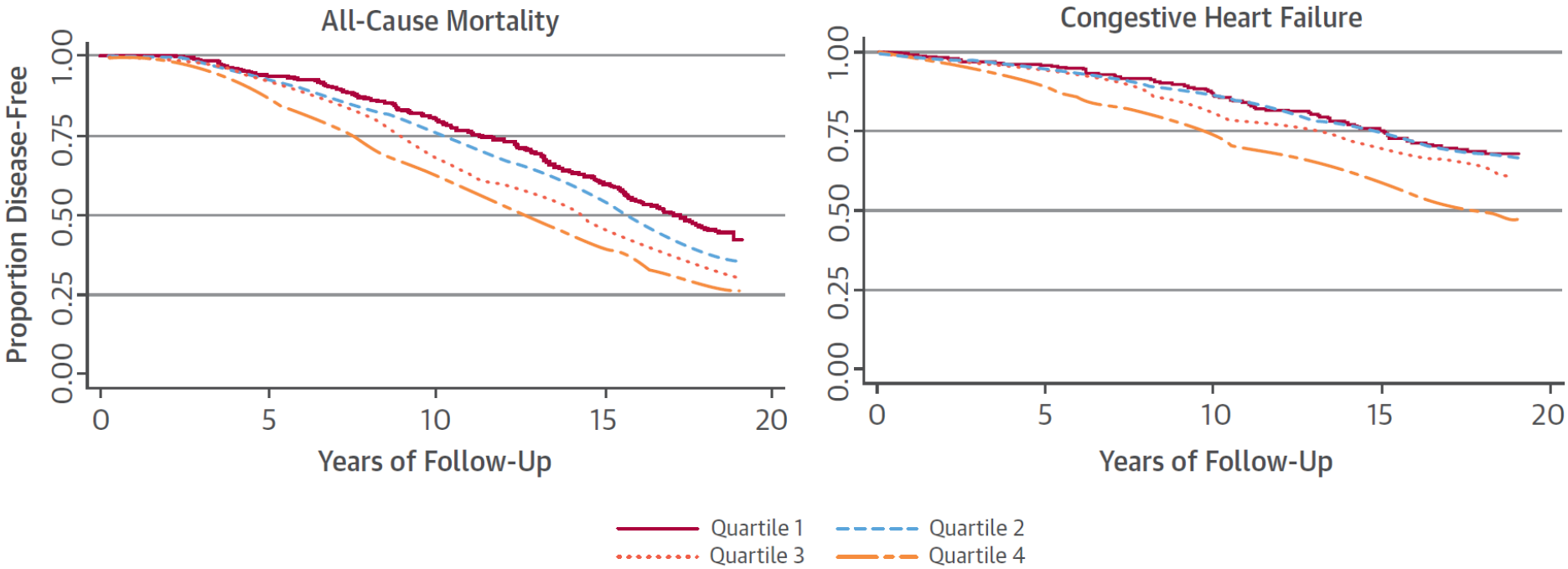


Dukes, J.W. et al. J Am Coll Cardiol. 2015; 66(2):101-9.



Dukes JW et al. J Am Coll Cardiol. 2015;66:101-9

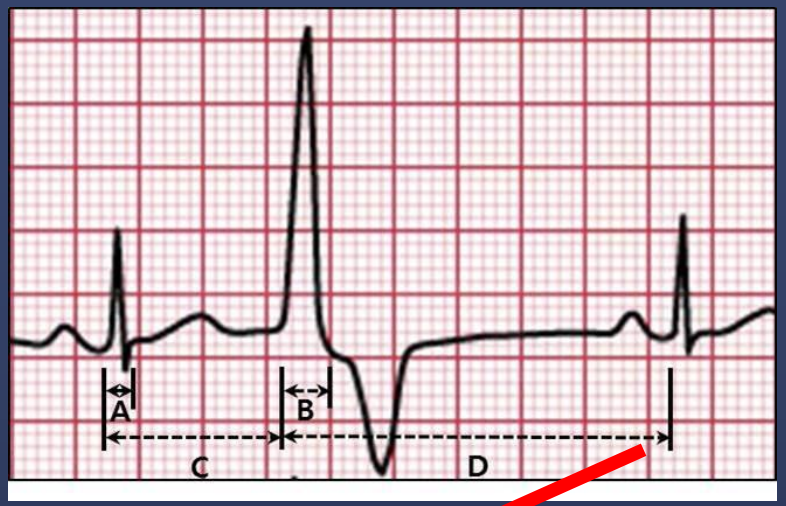
Other factors & Cardiomyopathy ?

• PVC QRS duration

Predictor	Study first author (Year)	Study design and population	Study findings
PVC QRS duration	Yokokawa (2012) [12]	Retrospective study	PVC QRS duration significantly greater in irreversible PVC-induced cardiomyopathy compared with reversible (164 ± 20 ms vs. 149 ± 17 ms; $P < 0.0001$)
		294 patients with frequent PVCs and impaired LVEF referred for ablation	Epicardial PVCs: widest QRS complexes
			PVC QRS >150 ms to differentiate patients with and without reversible PVC-induced cardiomyopathy
			PVC QRS ≥150 ms require a lower PVC burden for developing cardiomyopathy (22 ± 13% vs. 28 ± 12%; $P < 0.0001$)
	Carballeira (2014) [13▪]	Retrospective study	PVC QRS ≥ 153 ms predicts development of PVC-induced cardiomyopathy (sensitivity 82%, specificity 75%)
		45 patients with normal LVEF and ≥10% PVCs/24 h referred for ablation	Of 45 patients, with a PVC burden of ≥ 10%, 38% developed PVC-induced cardiomyopathy
			PVC burden similar, but those with LV dysfunction had wider PVC QRS (159 ms vs. 142 ms; $P < 0.001$)

Deyell MW et al. Heart Rhythm 2012;9:1465-72
del Carpio Munoz F et al. J Cardiovasc Electrophysiol 2011;22:791-8
Carballeira Pol L et al. Heart Rhythm 2014;11:299-306
Park KM et al. Int J Cardiol 2017;233:37-42

- **Coupling Interval**

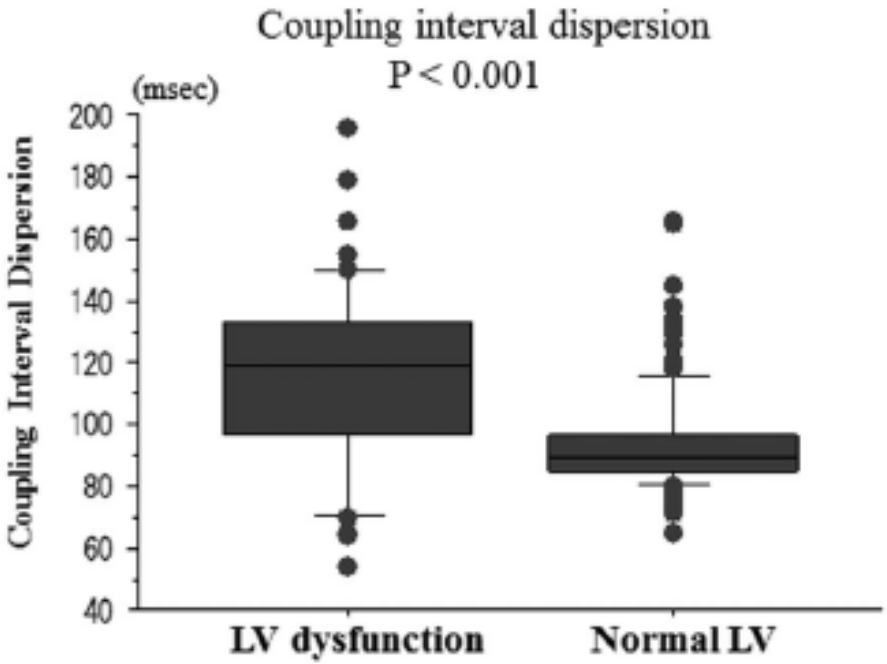


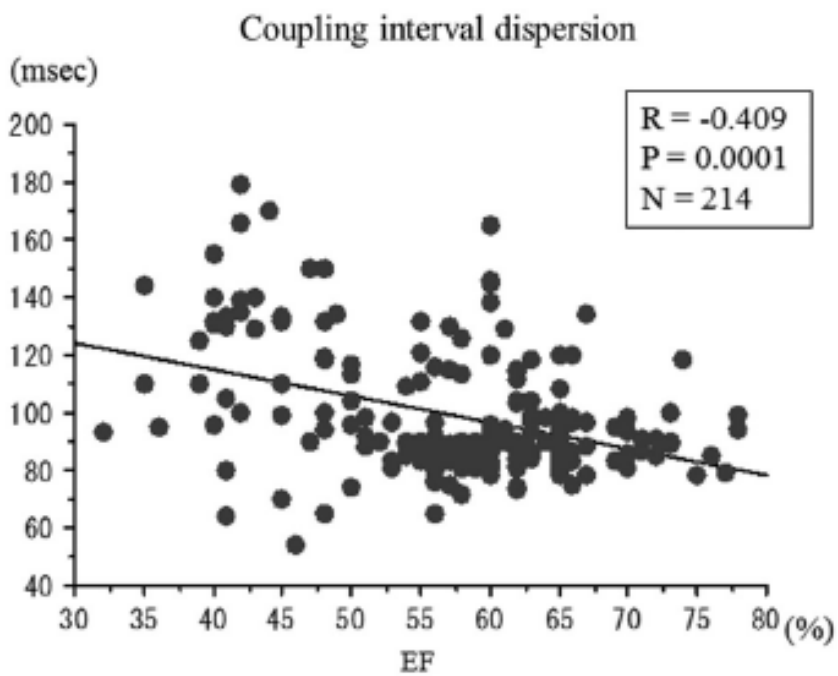
Predictor	Study first author (Year)	Study design and population	Study findings
PVC coupling interval	Del Carpio Munoz (2011) [14]	Retrospective study	No significant difference in the PVC coupling interval between those with reduced LVEF and those with normal LVEF in patients with frequent PVCs
		70 patients with frequent PVCs and impaired LVEF referred for ablation	
	Zhong (2014) [15▪]	Retrospective study	PVC coupling interval of <450 ms was an independent predictor of LVEF normalization
		510 patients with frequent PVCs (>1000/24 h) treated with ablation or antiarrhythmic therapy	

Coupling Interval Dispersion and Body Mass Index Are Independent Predictors of Idiopathic Premature Ventricular Complex-Induced Cardiomyopathy

MITSUHARU KAWAMURA, M.D., NITISH BADHWAR, M.D., VASANTH VEDANTHAM, M.D., PH.D., ZIAN H. TSENG, M.D., M.A.S., BYRON K. LEE, M.D., M.A.S., RANDALL J. LEE, M.D., PH.D., GREGORY M. MARCUS, M.D., M.A.S., JEFFREY E. OLGIN, M.D., EDWARD P. GERSTENFELD, M.D., and MELVIN M. SCHEINMAN, M.D.

From the Division of Cardiology, University of California, San Francisco, California, USA





J Cardiovasc Electrophysiol, 2014;25:756-762

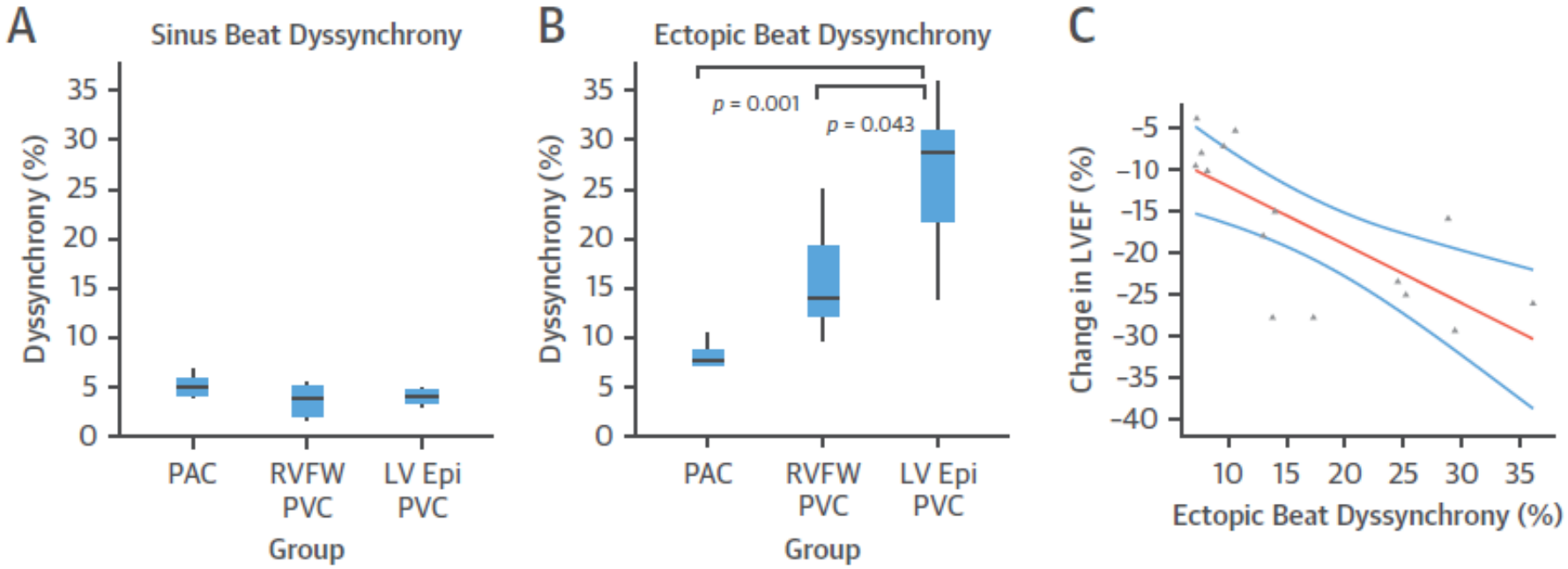
- **Interpolated PVCs**

Predictor	Study first author (Year)	Study design and population	Study findings
Interpolated PVCs	Olgun (2011) [16]	Retrospective study 51 patients with frequent PVCs referred for catheter ablation; no history of CAD or MI	Predictive of the presence of PVC-induced cardiomyopathy

Lee K, Deyell M. Curr Opin Cardiol 2016, 31:1–10

Left Ventricular Dyssynchrony Predicts the Cardiomyopathy Associated With Premature Ventricular Contractions

Tomos E. Walters, MD, PhD, Dolkun Rahmutula, MD, PhD, Judit Szilagyi, MD, Christina Alhede, MD, PhD, Richard Sievers, BS, Qizhi Fang, MD, Jeffrey Olgin, MD, Edward P. Gerstenfeld, MS, MD



Walters T et al. J Am Coll Cardiol 2018;72:2870–82

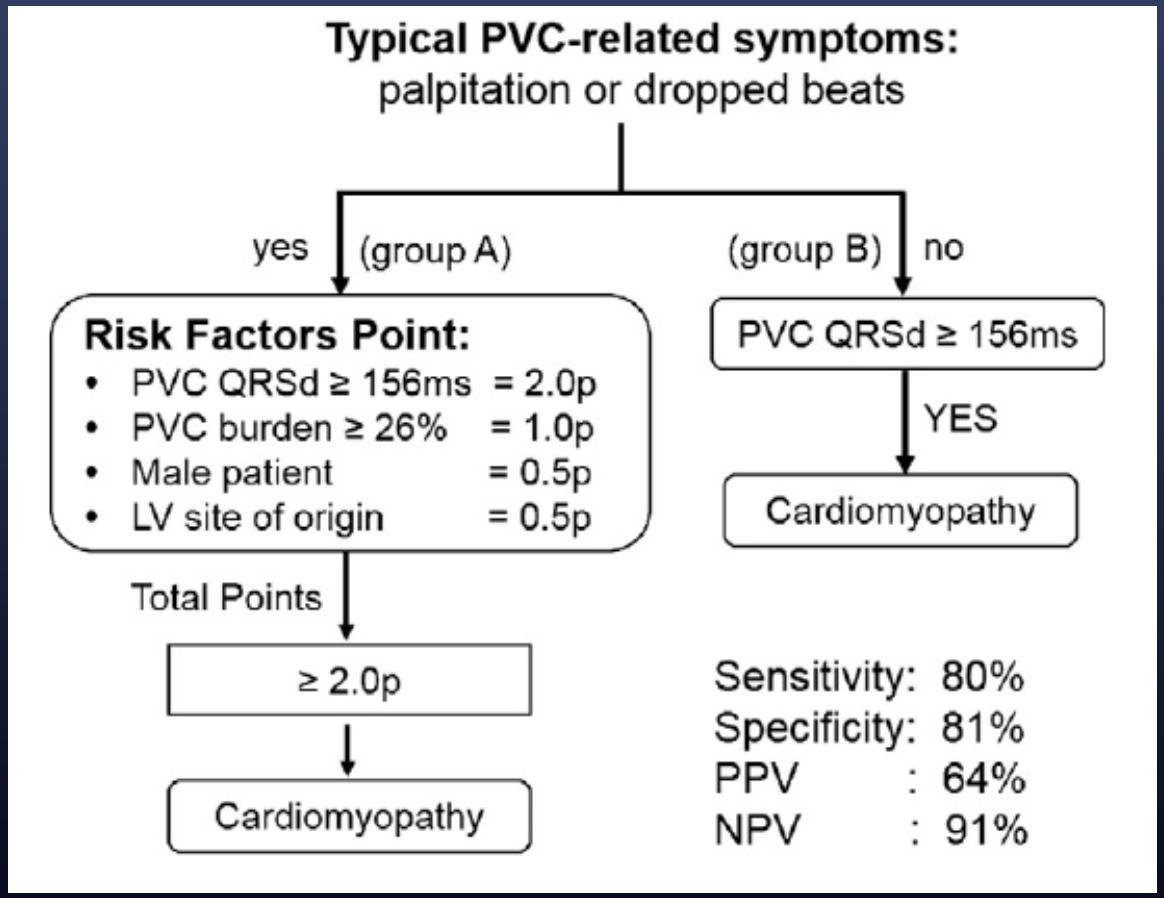
Contents lists available at ScienceDirect

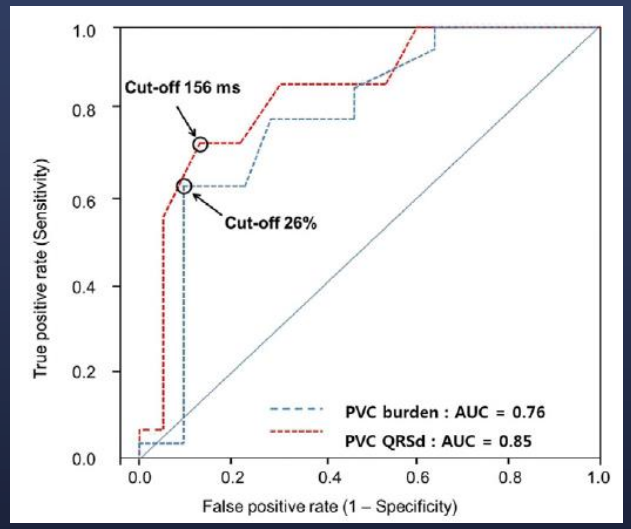
International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Risk factor algorithm used to predict frequent premature ventricular contraction-induced cardiomyopathy

Kyoung-Min Park [a,1], Sung Il Im [b,2], Seung-Jung Park [a], June Soo Kim [a], Young Keun On [a,*]



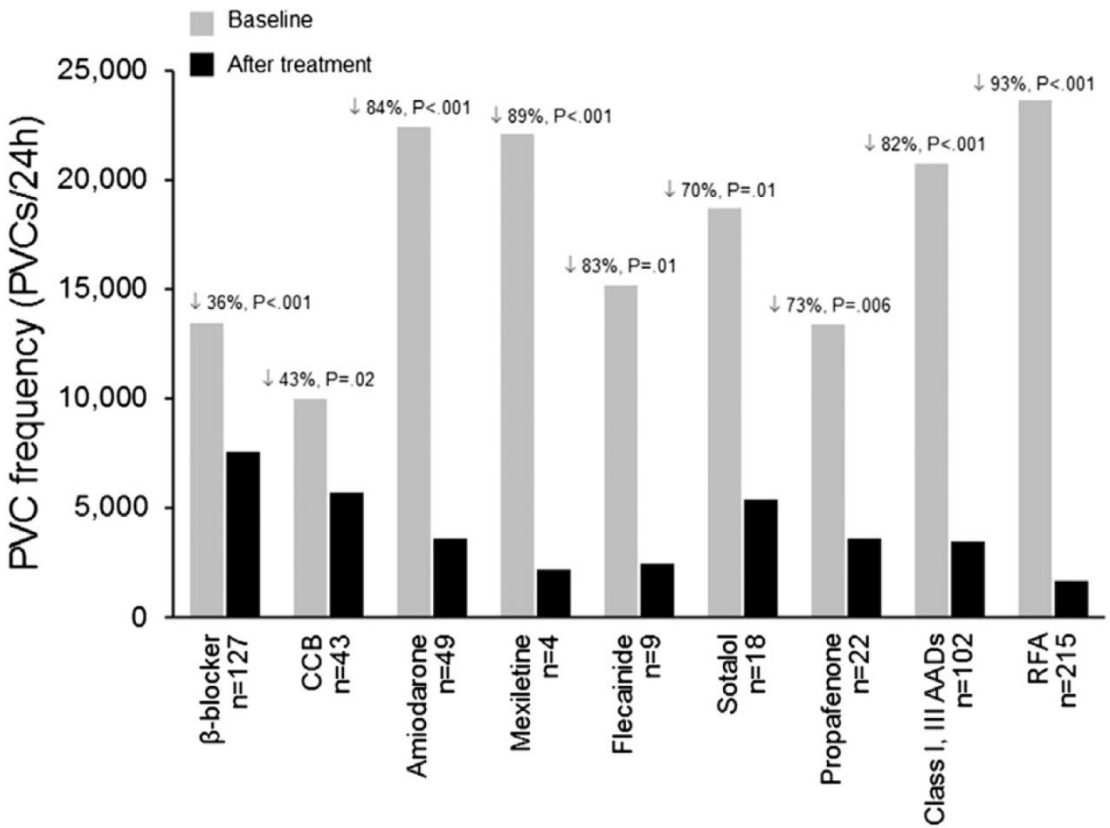


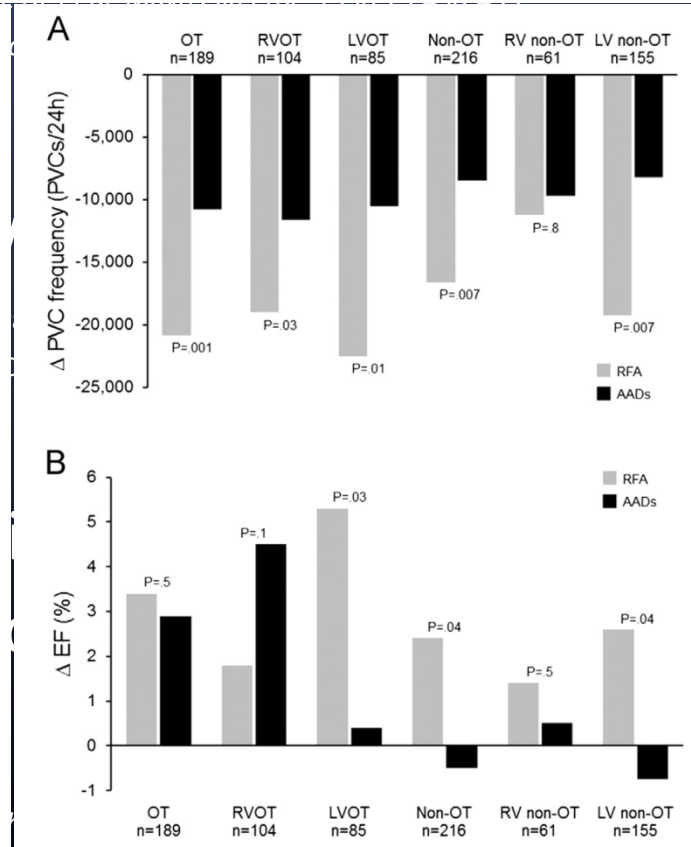
Park KM et al. International Journal of Cardiology 2017; 233: 37–42

AADs vs RF ablation

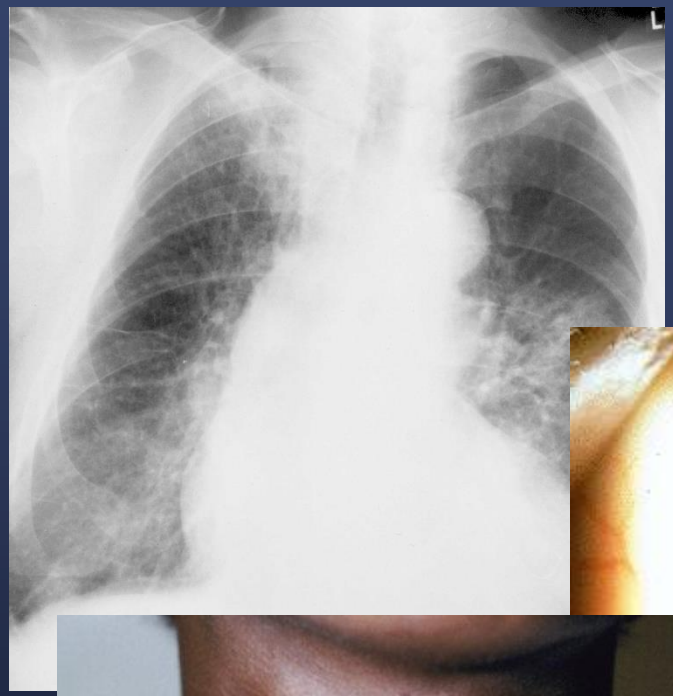
Relative efficacy of catheter ablation vs antiarrhythmic drugs in treating premature ventricular contractions: A single-center retrospective study

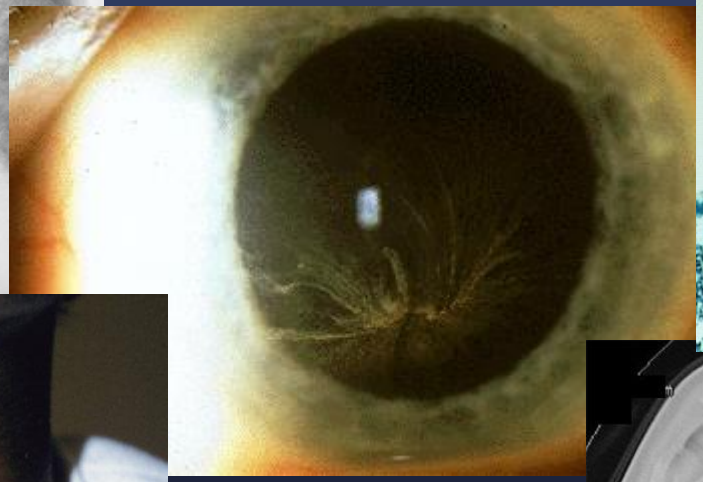
Li Zhong, MD, PhD,[*†] Ying-Hsiang Lee, MD,[†‡] Xin-Miao Huang, MD, PhD,[†§] Samuel J. Asirvatham, MD, FHRS,[†] Win-Kuang Shen, MD, FHRS,[†] Paul A. Friedman, MD, FHRS,[†] David O. Hodge, MS,[‖] Joshua P. Slusser, BS,[‖] Zhi-Yuan Song, MD,[*] Douglas L. Packer, MD, FHRS,[†] Yong-Mei Cha, MD, FHRS[†]

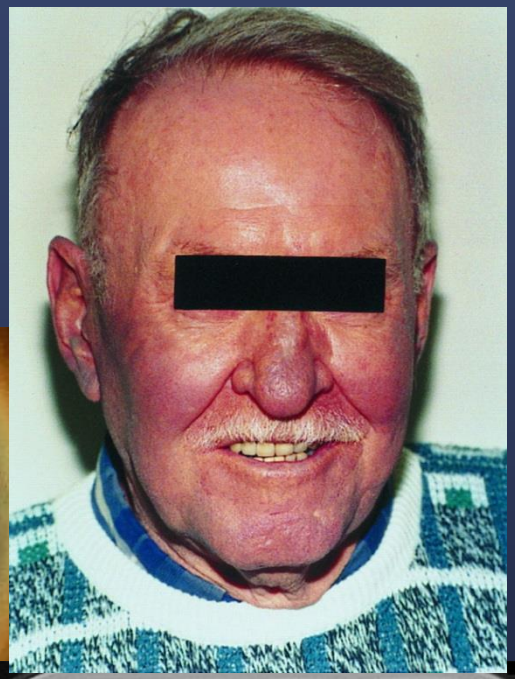


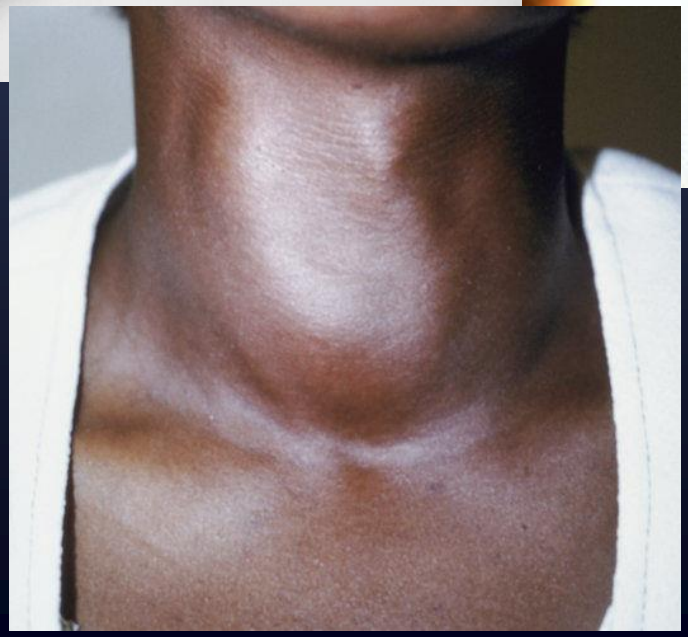


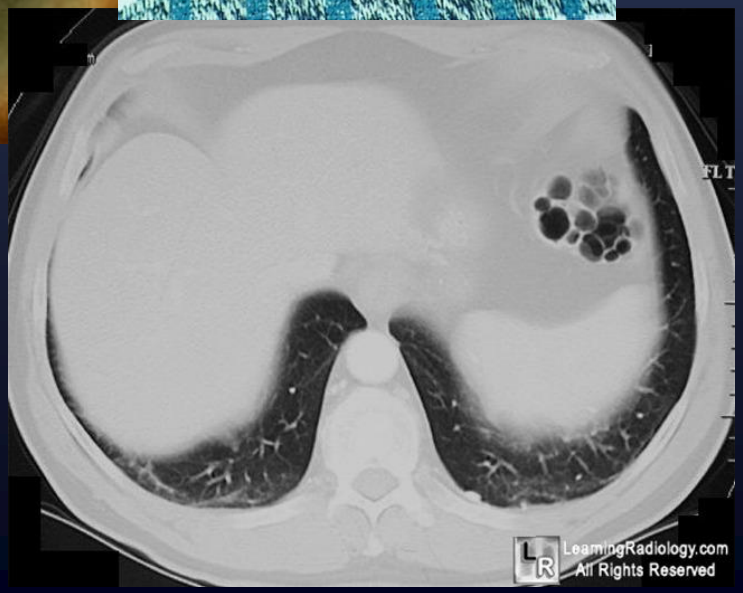
The numerous toxicities of amiodarone











Memories of CAST

THE NEW ENGLAND JOURNAL OF MEDICINE Aug. 10, 1989

SPECIAL REPORT

PRELIMINARY REPORT: EFFECT OF ENCAINIDE AND FLECAINIDE ON MORTALITY IN A RANDOMIZED TRIAL OF ARRHYTHMIA SUPPRESSION AFTER MYOCARDIAL INFARCTION

RF ablation

PVC ablation in 2018

Improved ECG localization of site of origin prior to ablation

Enhanced 3D mapping catheters (Pentaray, Rhythmia, Grid)

Intracardiac echocardiography

Irrigated contact force catheters – better deep lesion formation

No longer reliant on anti-arrhythmics!

RFA effects in CHF setting

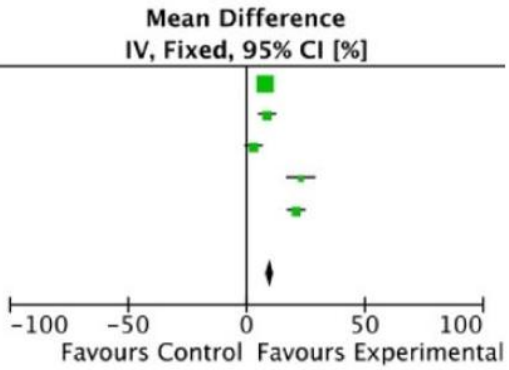
- Multiple studies suggest improvement in LV function post ablation
- Effect not limited to procedures with complete PVC elimination

Mountantonakis SE. Heart Rhythm 2011;8:1608-1614

- Meta-analysis of outflow tract PVCs

Study or Subgroup	Treatment Mean [%]	Treatment SD [%]	Treatment Total	Baseline Mean [%]	Baseline SD [%]	Baseline Total	Weight	Mean Difference IV, Fixed, 95% CI [%]
Ardashev et al, 2011	69.5	2.6	30	61.6	6.4	30	42.4%	7.90 [5.43, 10.37]
Kim et al, 2010	59.8	7.2	24	51.1	6.6	24	17.0%	8.70 [4.79, 12.61]
Wijnmaalen et al, 2010	59	5	23	56	8	23	17.4%	3.00 [-0.86, 6.86]
Yarlagadda et al, 2005	62	6	7	39	6	7	6.6%	23.00 [16.71, 29.29]
Yokokawa et al, 2012	60	4	24	39	9	24	16.7%	21.00 [17.06, 24.94]
Total (95% CI)			**108**			**108**	**100.0%**	**10.36 [8.75, 11.97]**

Heterogeneity: $\chi^2 = 62.04$, df = 4 ($P < 0.00001$); $I^2 = 94\%$
Test for overall effect: $Z = 12.61$ ($P < 0.00001$)



Lamba J et al PACE 2014;37:73-78

Efficacy of ablation

- PENN experience (~100 PVC ablations/year 2008-2010)
- A large proportion of patients had a prior failed procedure

60% of procedures left-sided

85-90% Success

Difficult sites:
- Papillary muscles
- AIV/epicardial

<1% Major Complications

- Even lower with right-sided procedures
- 1/500-1/1000 chance of disability or death

Summary

- Whether or not there is a symptom due to PVC is irrelevant to PVC-induced CMP
- The higher daily PVC burden, the higher is the mortality, and a risk factor of the outbreak of PVC-induced CMP
- PVC QRS duration, interpolated PVCs, CI dispersion, site of origin are also important predictors of PVC-induced CMP
- The RF ablation procedure of ventricular arrhythmia is well accepted treatment with proven efficacy and safety

Thank you!