The prognostic significance of the 12-lead ECG in peripartum cardiomyopathy

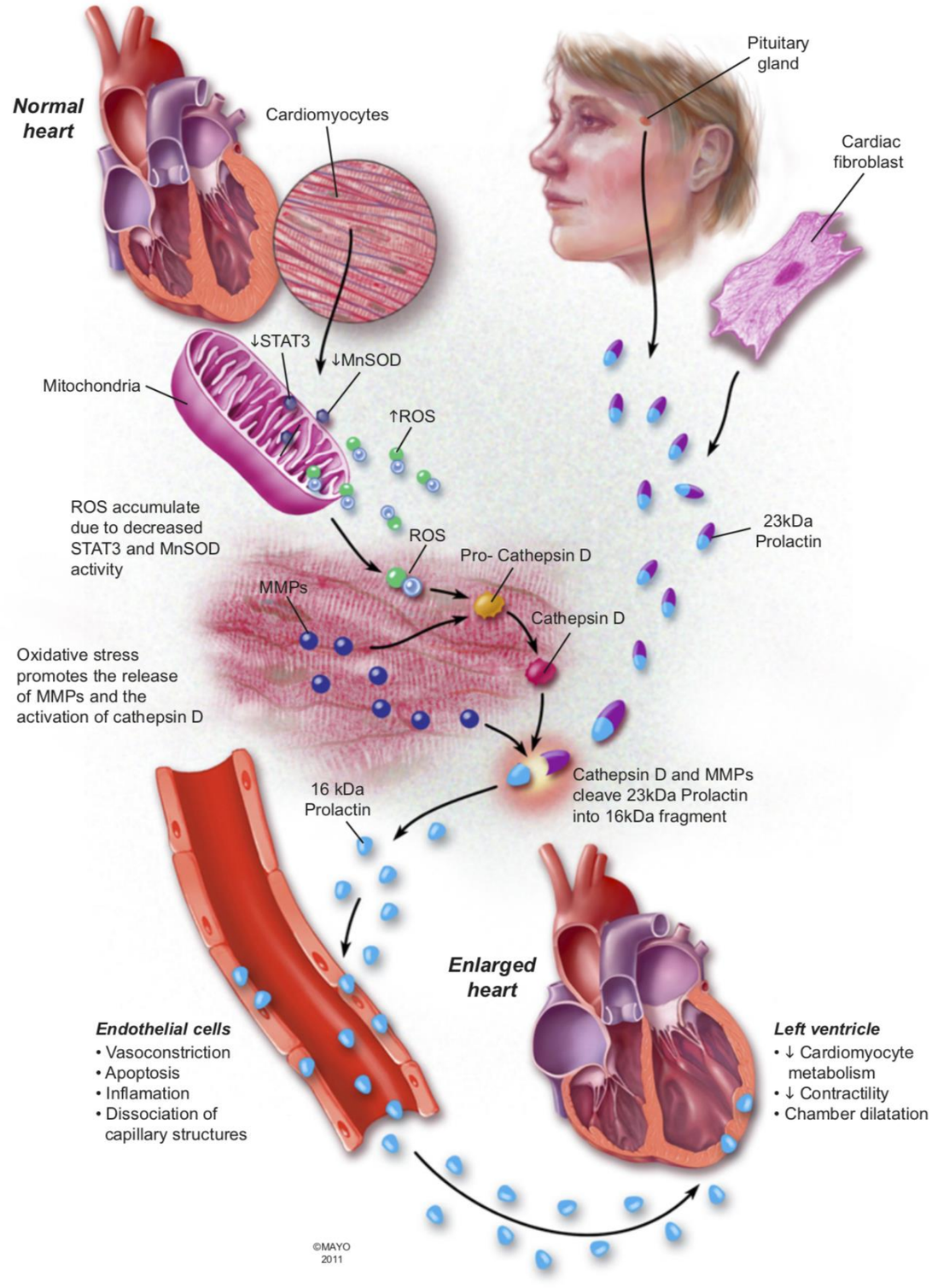
Julian Hövelmann, Charle Viljoen, Kathryn Manning, Johann Baard, Lina Hähnle, Mpiko Ntsekhe, Johann Bauersachs, Karen Sliwa

Peripartum cardiomyopathy (PPCM)

Defined as heart failure secondary to left ventricular (LV) systolic dysfunction, which develops in women without previous heart disease towards the end of pregnancy or up to five months following delivery.

Though the exact aetiology is unclear, the effects of oxidative stress on prolactin seem to play a crucial part in the pathogenesis.

PPCM contributes significantly to maternal morbidity and mortality worldwide, and remains the largest cause of cardiovascular maternal death in South Africa.



Sliwa K, Hilfiker-Kleiner D, Petrie MC, Mebazaa A, Pieske B, Buchmann E, et al. Current state of knowledge on aetiology, diagnosis, management, and therapy of peripartum cardiomyopathy: a position statement from the Heart Failure Association of the European Society of Cardiology Working Group on peripartum cardiomyopathy. Eur J Heart Fail. 2010;12(8):767-78.

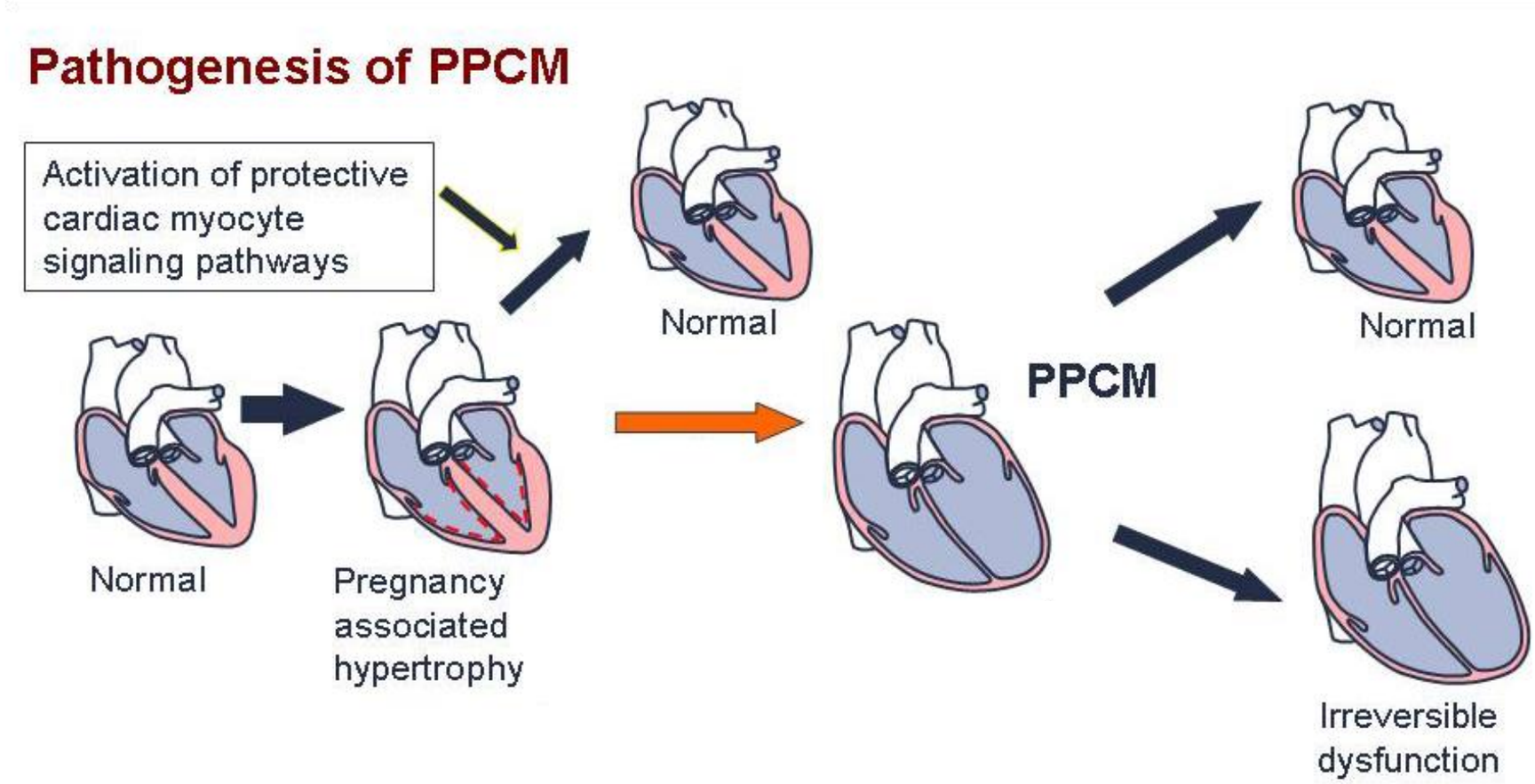
Hilfiker-Kleiner D, Kaminski K, Podewski E, Bonda T, Schaefer A, Sliwa K, et al. A cathepsin D-cleaved 16 kDa form of prolactin mediates postpartum cardiomyopathy. Cell. 2007;128(3):589-600.

Sliwa K, Anthony J. Late maternal deaths: a neglected responsibility. The Lancet. 2016;387(10033):2072-3.

Blauwet LA, Cooper LT. Diagnosis and management of peripartum cardiomyopathy. Heart. 2011;97(23):1970-81.

Peripartum cardiomyopathy (PPCM)

Although LV recovery is more likely in PPCM than in other forms of non-ischaemic cardiomyopathy, the outcome of PPCM is heterogenous.



It remains difficult to predict which patients will have full LV recovery and which will continue to develop chronic heart failure with persistently reduced LV ejection fraction (LVEF).

Sliwa K, Fett J, Elkayam U. Peripartum cardiomyopathy. Lancet. 2006;368(9536):687-93.

The ECG in PPCM

Although **ECG abnormalities are common** at the time of diagnosis of PPCM

- it is not known whether any ECG features are specific to the condition
- the prognostic value of the 12-lead ECG has not yet been established in PPCM

Why is this important?

The ECG is

- one of the **most frequently performed diagnostic procedures** in cardiovascular disease
- **inexpensive** and **widely available**, even in healthcare centres with limited resources

Methods

We included all consenting patients diagnosed with PPCM and seen at the Groote Schuur Hospital Cardiac Clinic between 2012 and 2017.

Index presentation	6 month follow-up
Demographic information	
Obstetric history	
Comorbidities	
Clinical details	Clinical details
ECG	**ECG**
Echo	Echo
Treatment	Treatment

Poor outcome as determined by the composite endpoint

- Death
- Readmission prior to follow-up
- Remaining NYHA III / VI
- Persistent LVEF < 35% at follow-up

With regards to the ECG, we specifically analysed

Ventricular / QRS rate

- normal rate
- tachycardia
- bradycardia

Rhythm

- sinus rhythm with regular RR interval
- sinus arrhythmia / heart rate variability
- atrial fibrillation
- atrial flutter

Evidence of any premature complexes

- premature atrial complexes
- premature ventricular complexes

With regards to the ECG, we specifically analysed

P wave

- left atrial enlargement
- right atrial enlargement

PR interval

- interval measured (prolonged > 200ms)
- PR segment deviation

QRS complex

- width measured (wide > 120ms)
- axis calculated
- R wave progression
- small complexes
- LVH (Sokolow-Lyon, Cornel, lead I, lead aVL, lead V2)
- dominant R in V1
- bundle branch blocks (LAFB, LBBB, RBBB)
- Q waves

With regards to the ECG, we specifically analysed

QRS complex (continued)

- fractionated QRS
- J waves
- electrical alternans

ST segment

- elevation
- depression

T waves

- inversion
- flat T waves
- tall T waves

QTc

- by Bazett’s formula
- by Fridericia formula

Results

Baseline characteristics	n = 66
Age (in years)	28.59 (25.42 - 32.19)
Ethnicity	
African or Black	37 (56.06)
Mixed ancestry	25 (27.88)
Caucasian	4 (6.06)
Parity	2 (1-3)
BMI	25.65 (22.5-29.69)
NYHA class	
I / II	36/64 (56.25)
III / IV	28/64 (43.75)
LVEF (in %)	33 (25-40)
LVEDD (mm)	58 (53-63)
Discharge Medication	
Carvedilol	59 (89.39)
ACE-I/ARBs	49 (74.24)
Spironolactone	24 (36.36)
Diuretics	57 (86.36)
Bromocriptine	30 (45.45)

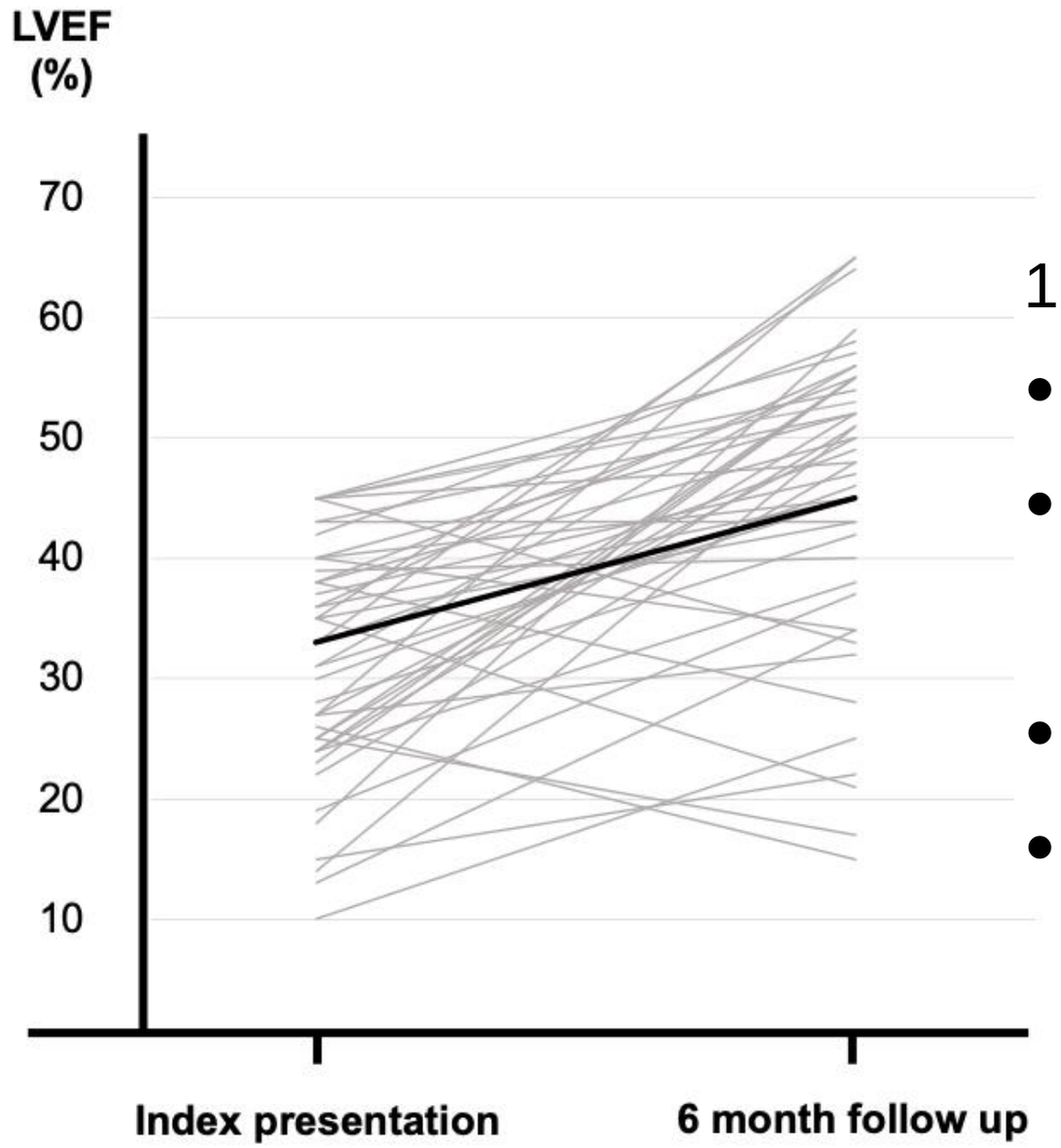
ACE-I = angiotensin converting enzyme inhibitor, ARB = angiotensin receptor blocker, BMI = body mass index, LVEDD = left ventricular end-diastolic diameter, LVEF = left ventricular ejection fraction, NYHA = New York Heart Association; Values are n (%),
Mean ± SD or Median (IQR)

ECG at index presentation	n = 66
QRS rate (per min)	86.5 (72-103)
PR interval (ms)	142 (124-160)
QRS width (ms)	82 (78-88)
QTc interval	456 (427-473)
Sinus tachycardia	21 (31.82)
Sinus arrhythmia	22 (33.33)
Bundle branch block	0 (0.00)
LVH	17 (25.76)
Poor R wave progression	25 (37.88)
J wave	27 (40.91)
Pathological Q waves	12 (18.46)
T wave inversion	46 (70.77)
Prolonged QTc interval (≥460ms)	29 (43.94)

LVH = left ventricular hypertrophy;
Values are n (%), Mean ± SD or Median (IQR)

Outcome

The median LVEF at presentation (LVEF of 33%, IQR 25-40) improved significantly 6 months later (49%, IQR 39-55, *P*<0.001).

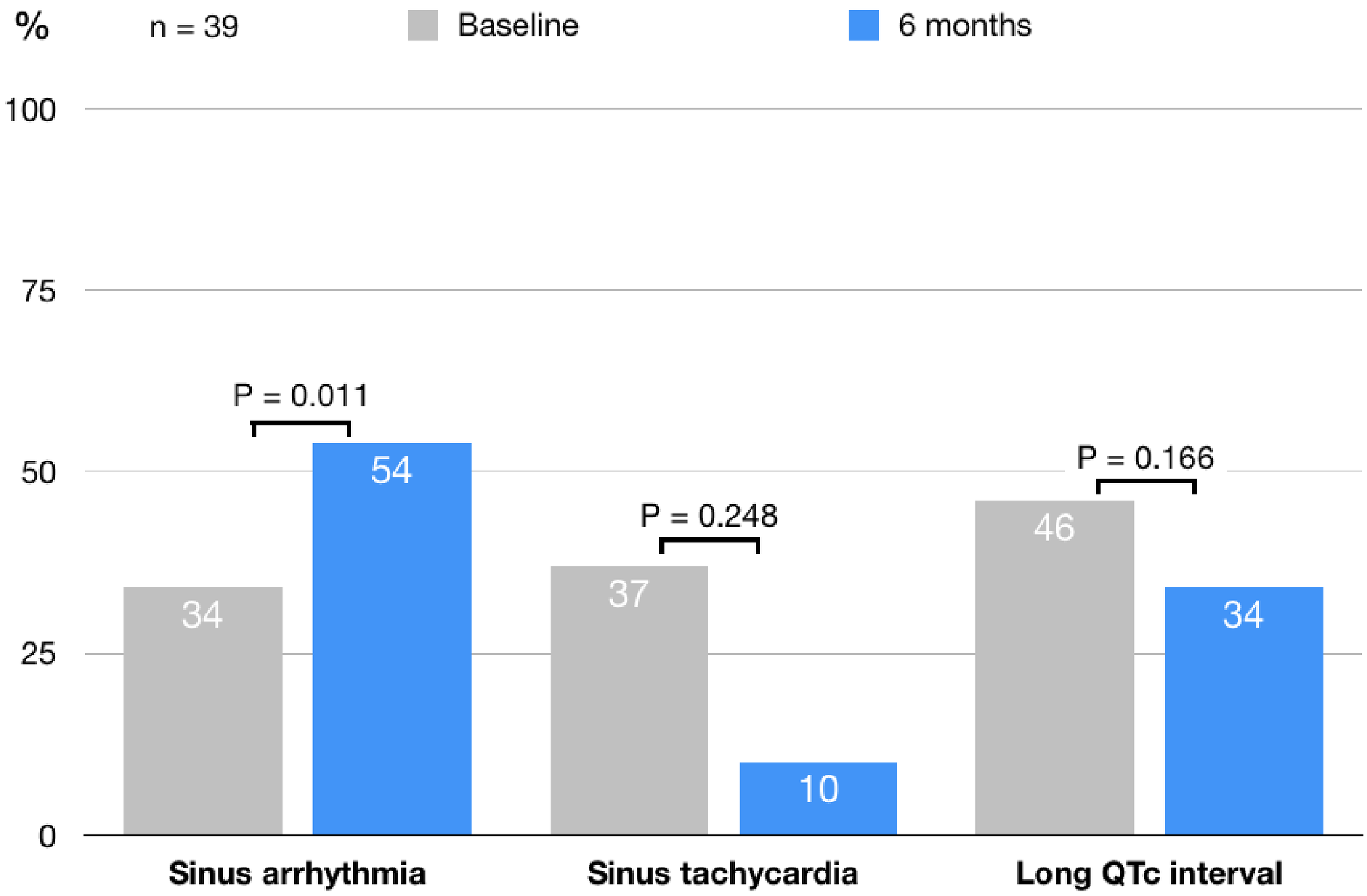


12 patients (27.81%) had a poor outcome:

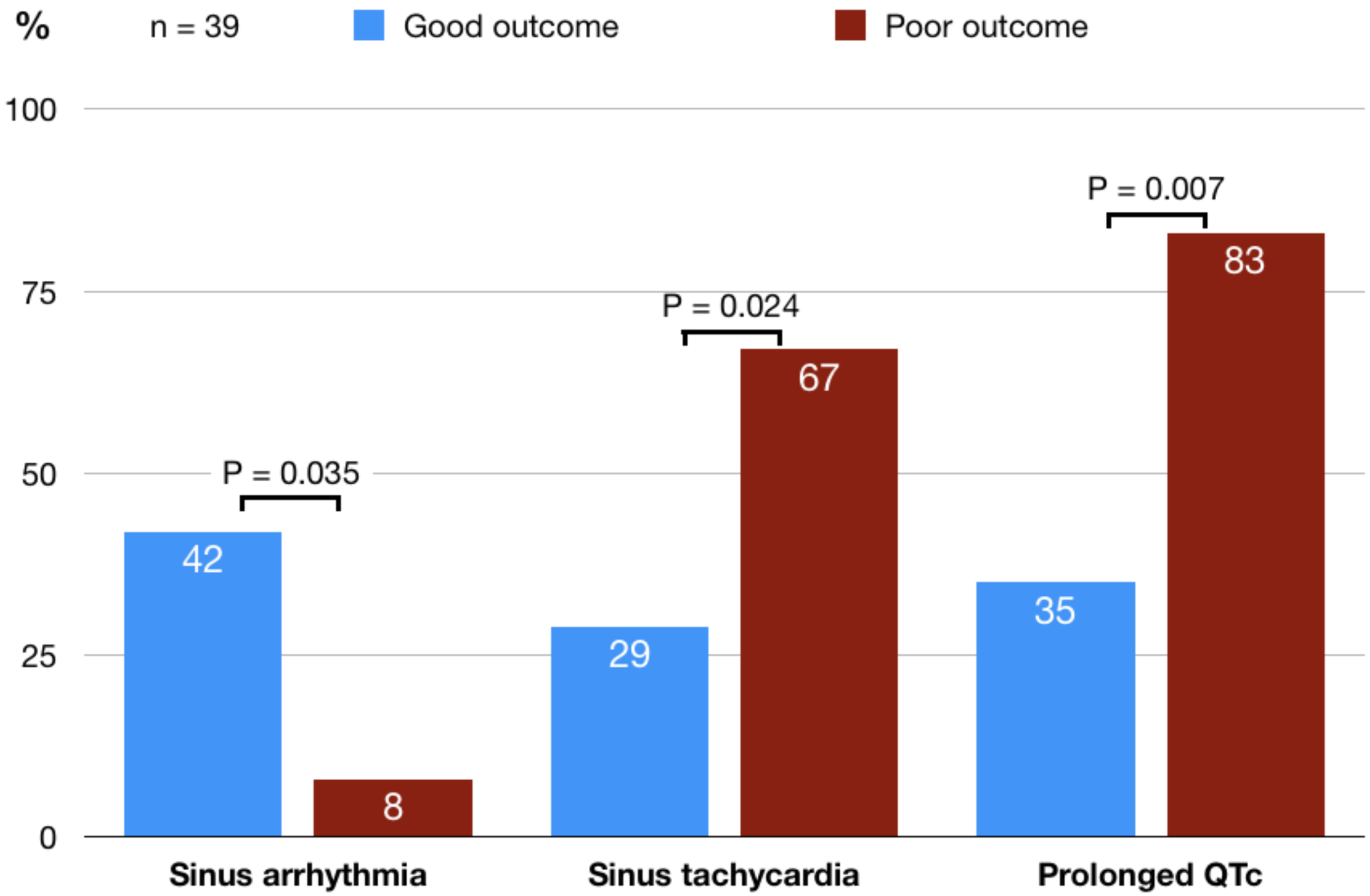
- 2 women died
- 9 patients were readmitted to hospital

  (8 with heart failure, 1 with stroke)
- 2 patients remained in NYHA class III
- 8 patients had LVEF < 35% at follow-up

Baseline ECG compared with ECG at 6 months



Baseline ECG features that predicted outcome



Logistic regression analysis of predictors of poor outcome

Univariable logistic regression analysis

ECG feature	Unadjusted OR	95% CI	P value
Sinus tachycardia	4.89	1.17-20.41	0.030
Sinus arrhythmia	0.13	0.01-1.10	0.061
Poor R wave progression	1.38	0.36-5.28	0.633
Pathological Q wave	0.38	0.04-3.53	0.394
T wave inversion	0.95	0.24-3.93	0.946
Prolonged QTc interval	9.09	0.68-49.12	0.010

Multivariable logistic regression analysis

ECG feature	Adjusted OR	95% CI	P value
Sinus tachycardia	2.57	0.53-12.52	0.244
Prolonged QTc interval	6.34	1.06-37.80	0.043

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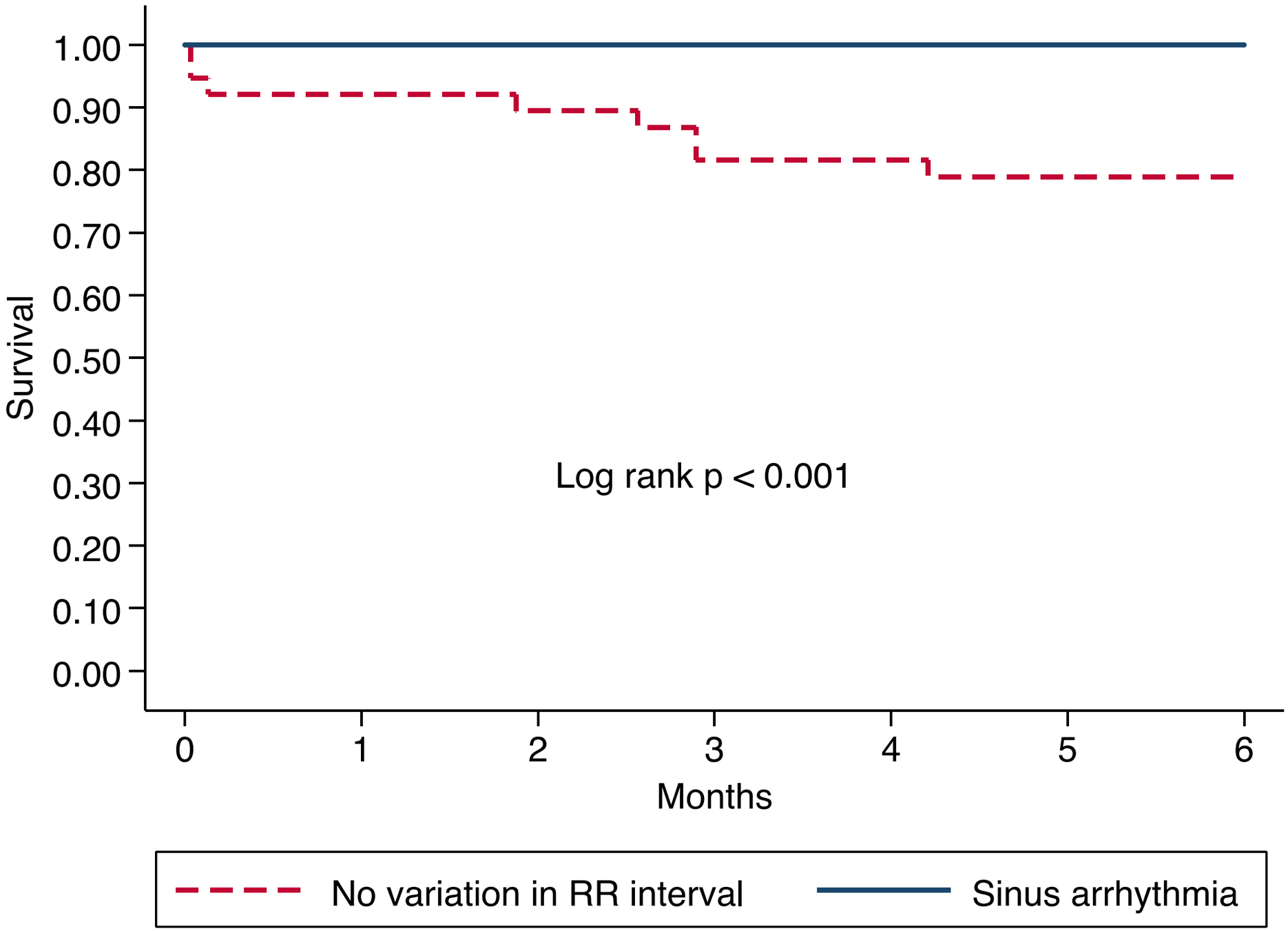
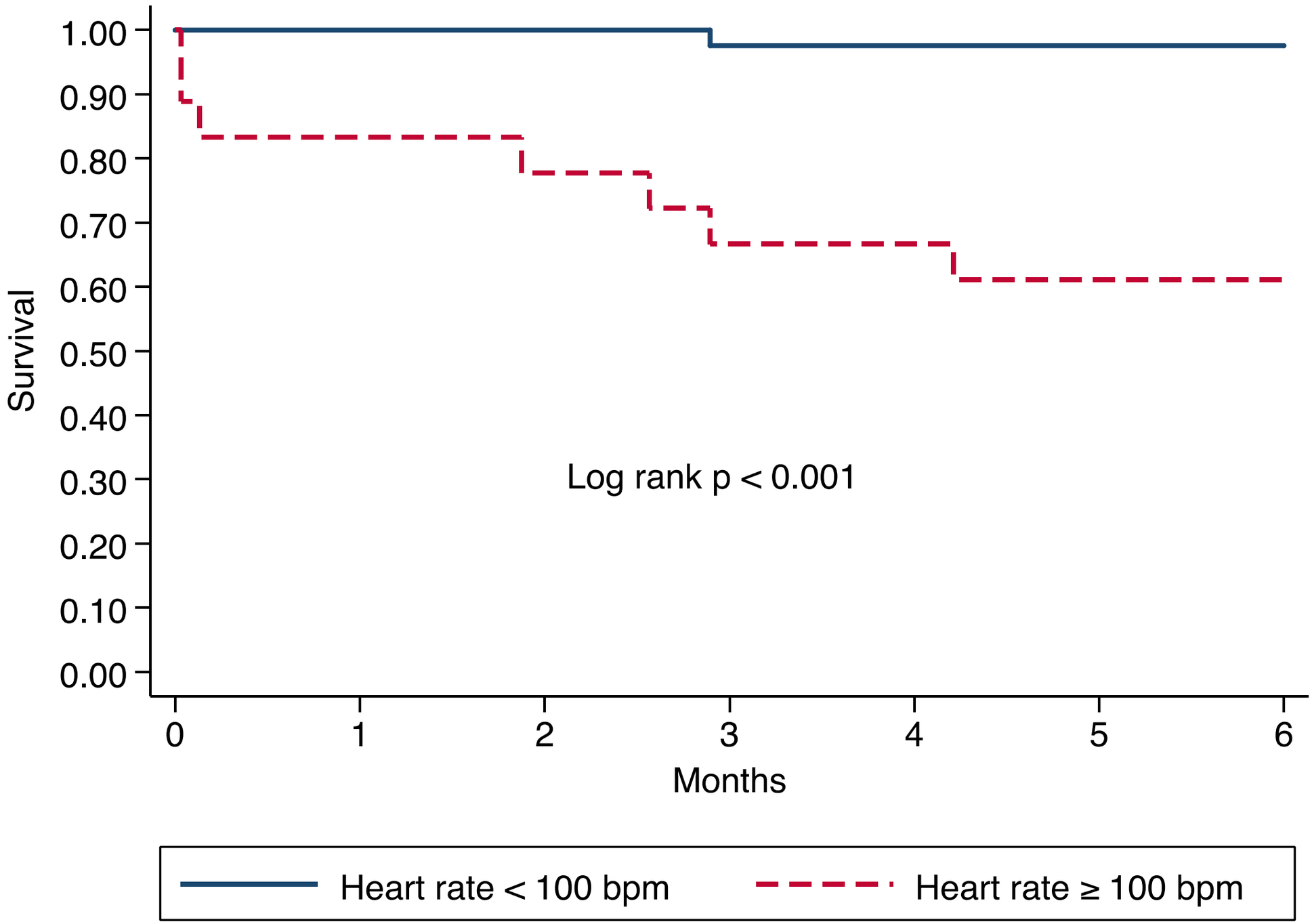
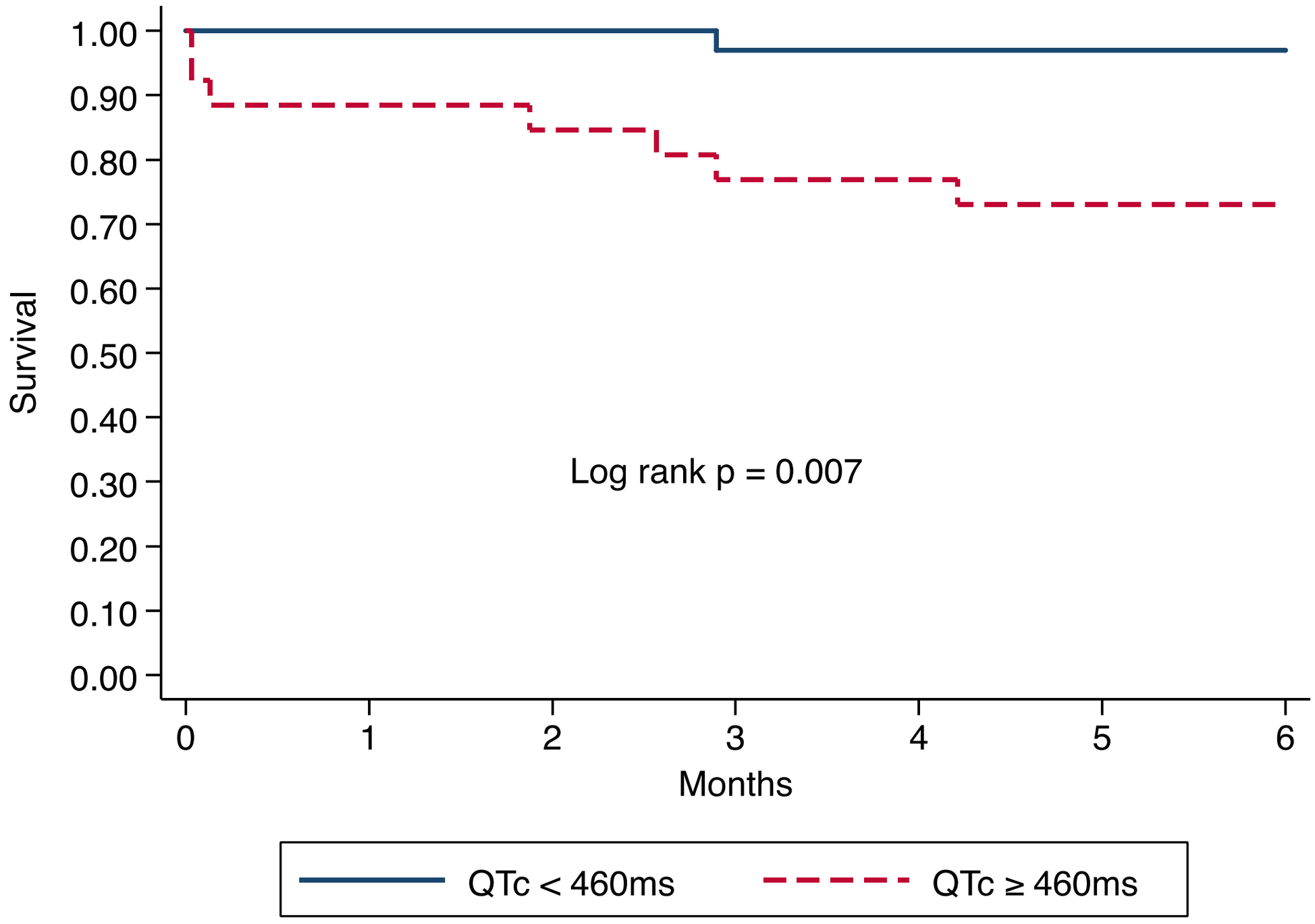
Kaplan-Meier survival curves showing total death and readmission rates for sinus arrhythmia



Kaplan-Meier survival curves showing total death and readmission rates for sinus tachycardia



Kaplan-Meier survival curves showing total death and readmission rates for prolonged QTc



Additional findings

All patients had at least one major ECG abnormality, including: sinus tachycardia, right or left axis deviation, pathological Q waves, poor R wave progression, T wave inversion, or long QTc interval.

Although 17 patients met Sokolow-Lyon criteria for **LVH** on the ECG, echocardiography showed LVH in only 1 patient (PPV 0, NPV 97%).

T wave inversion in any lead was associated with an LVEF <35% at presentation (OR 5.45, 95% CI 1.64-18.09, P=0.006), but did not predict longterm outcome.

Conclusion

ECG abnormalities are frequently encountered in PPCM.

We found that **sinus tachycardia** and **prolonged QTc** interval on the index ECG were associated with poor outcome after 6 months, whereas **sinus arrhythmia** was associated with good outcome.

Having identified these predictive ECG features would allow for improved risk stratification and follow-up of patients with PPCM.

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Thank you for your attention