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der Universität Heidelberg

Universitätsklinikum Mannheim

Management of electrical storm

Prof. Dr. Martin Borggrefe

Mannheim

Advances in cardiac arrhythmias and great innovations in cardiology

Turin, September 27-28, 2013

ACC/AHA/ESC Guidelines for Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death

COMMITTEE MEMBERS

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CONSENSUS DOCUMENT

EHRA/HRS Expert Consensus on Catheter Ablation of Ventricular Arrhythmias

Developed in a partnership with the European Heart Rhythm Association (EHRA), a Registered Branch of the European Society of Cardiology (ESC), and the Heart Rhythm Society (HRS); in collaboration with the American College of Cardiology (ACC) and the American Heart Association (AHA)

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Management of electrical storm

Definition of electrical storm

Three or more separate arrhythmia episodes leading to ICD therapies [antitachycardia pacing (ATP) or shock] occurring over a single 24 h time period

Electrical storm – clinical approach

- underlying cardiac disease
- electrical stability
- hemodynamic stability
- configuration of QRS
- morphology
- antiarrhythmic drugs

  (QT prolongation, QRS width)

Electrical storm – clinical approach

underlying cardiac disease

YES

- CAD ± infarction
- DCM
- HCM
- ARVD
- Valvular heart disease

NO

- Idiopathic VT / VF
- LQTS
- Brugada syndrome
- J-wave syndromes

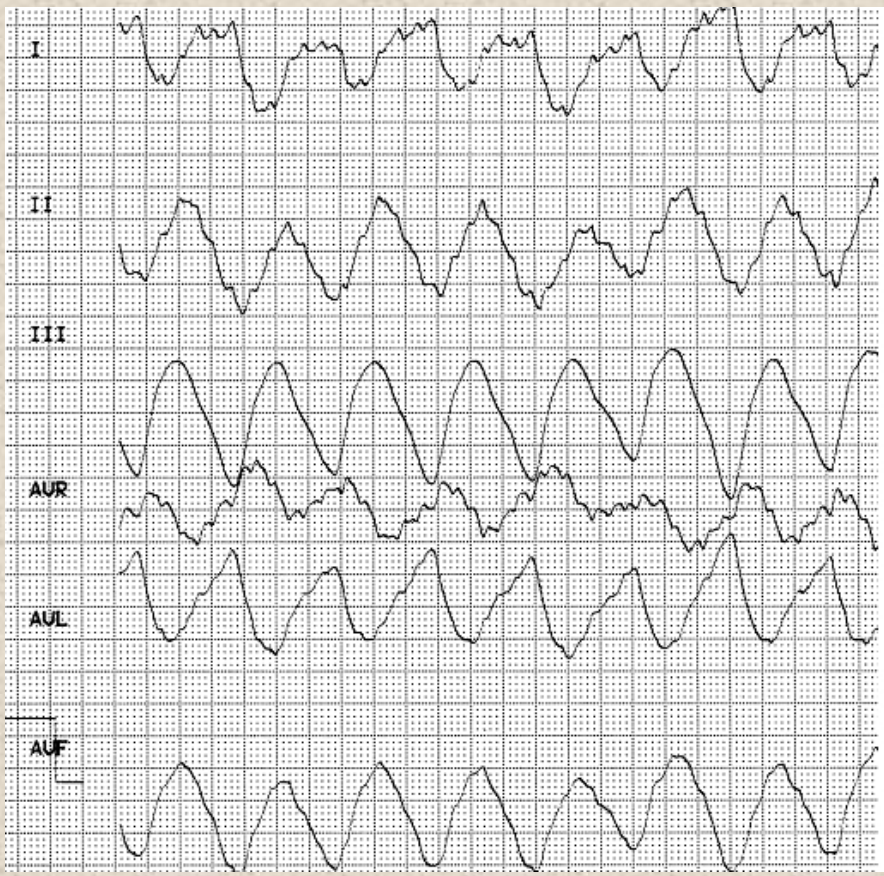
Brugada Syndrome

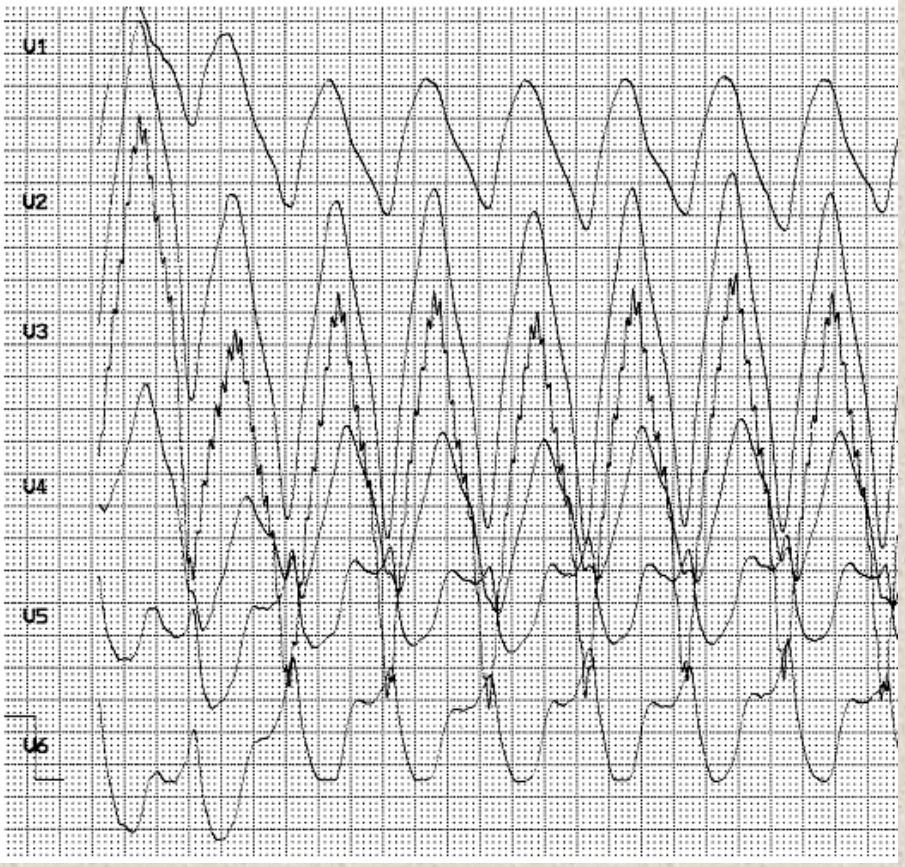
Yew intoxication (Taxus baccata)

Veltmann et al. Circulation 2009; 119:1836-1837

Brugada Syndrome

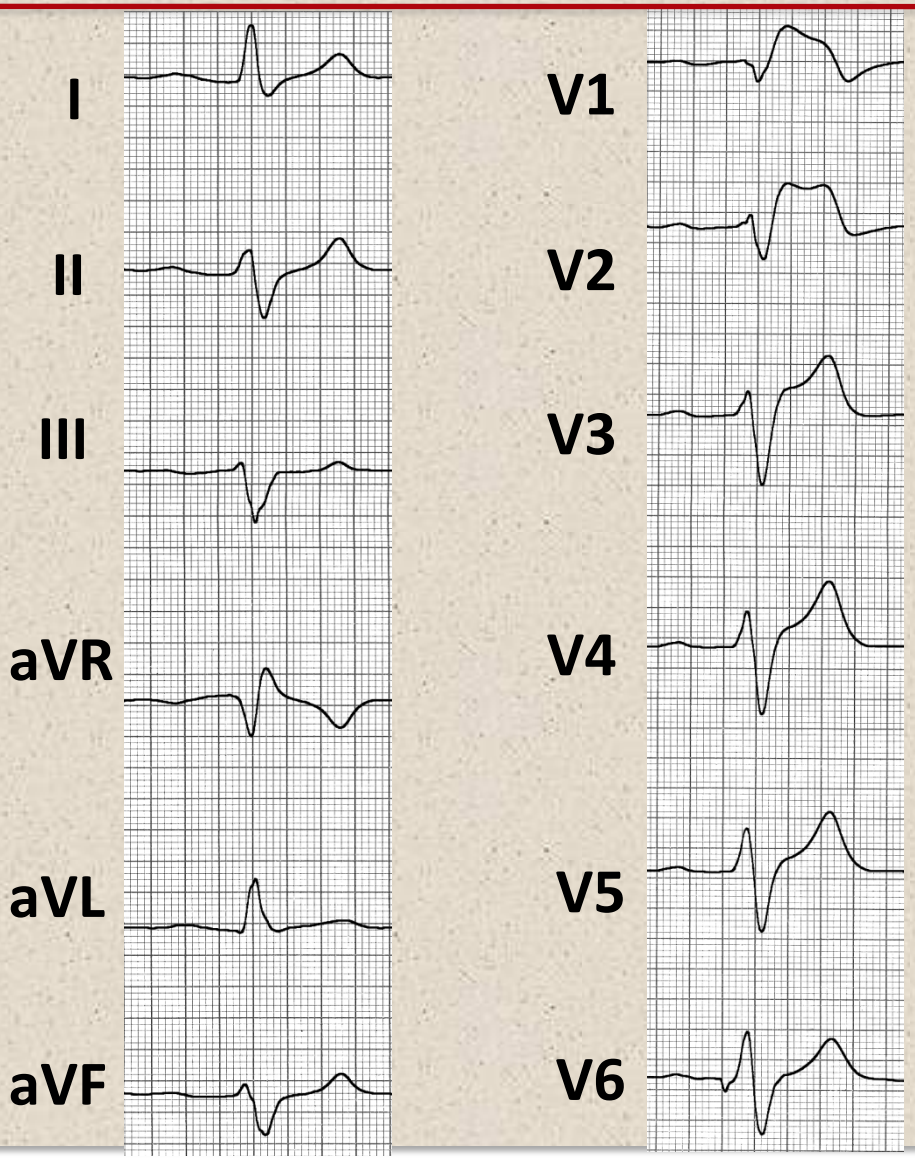
Yew Intoxication (taxine A, B)





Veltmann et al. Circulation 2009; 119:1836-1837

Brugada Syndrome



Yew Intoxication (taxine A, B)

Veltmann et al. Circulation 2009; 119:1836-1837

Brugada Syndrome

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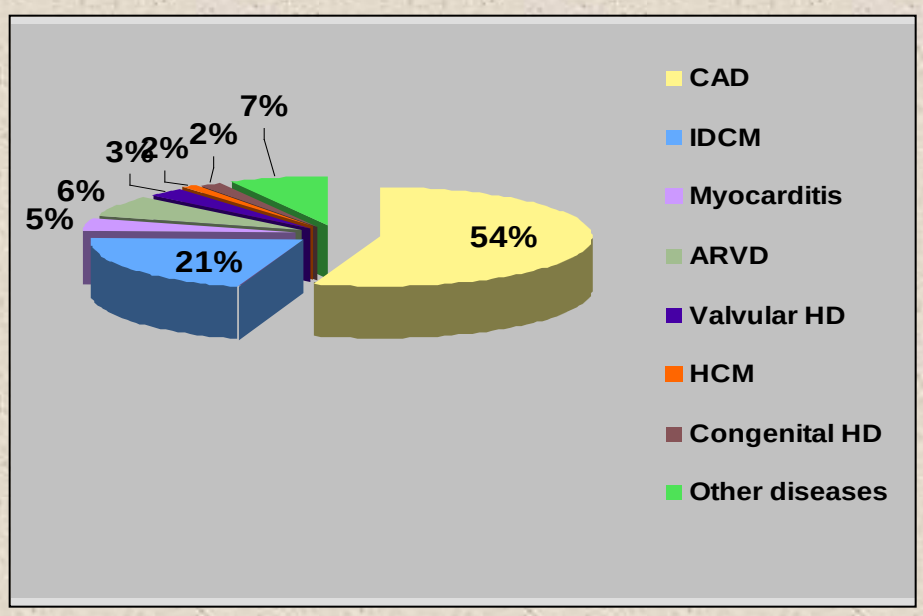


Advanced VT Care Unit (2007- 2011)

616 Patients with VT in the setting of structural heart disease – Catheter ablation in 528 (86%)

Circulation 2013;127:1359-1368

Management of Ventricular Tachycardia in the Setting of a Dedicated Unit for the Treatment of Complex Ventricular Arrhythmias

Long-Term Outcome After Ablation

Paolo Della Bella, MD; Francesca Baratto, MD; Dimitris Tsiachris, MD; Nicola Trevisi, MD; Pasquale Vergara, MD; Caterina Bisceglia, MD; Francesco Petracca, MD; Corrado Carbucicchio, MD; Stefano Benussi, MD; Francesco Maisano, MD; Ottavio Alfieri, MD; Federico Pappalardo, MD; Alberto Zangrillo, MD; Giuseppe Maccabelli, MD

Table 1. Baseline Clinical Characteristics of Patients Who Underwent Ablation of VT

Age, y	62.1±14
Males/females, n	473/55
Left ventricular ejection fraction, %	38.5±13
Left ventricular ejection fraction ≤30%	190 (36)
New York Heart Association class	
Class I	183 (34.7)
Class II	194 (36.7)
Class III	129 (24.4)
Class IV	22 (4.2)
Prior amiodarone therapy	410 (77.7)
Amiodarone adverse reaction	79 (15)
Renal disease	117 (22.2)
Atrial fibrillation	124 (23.5)
Implantable cardioverter defibrillator	432 (81.8)
Nontolerated VT	196 (37.1)
Electrical storm	151 (28.6)
Incessant VT	58 (11)
High risk/low risk, n	221/307

Management of electrical storm

Predictors of electrical storm recurrences in patients witch ICD

1993 – 2008

955 patients

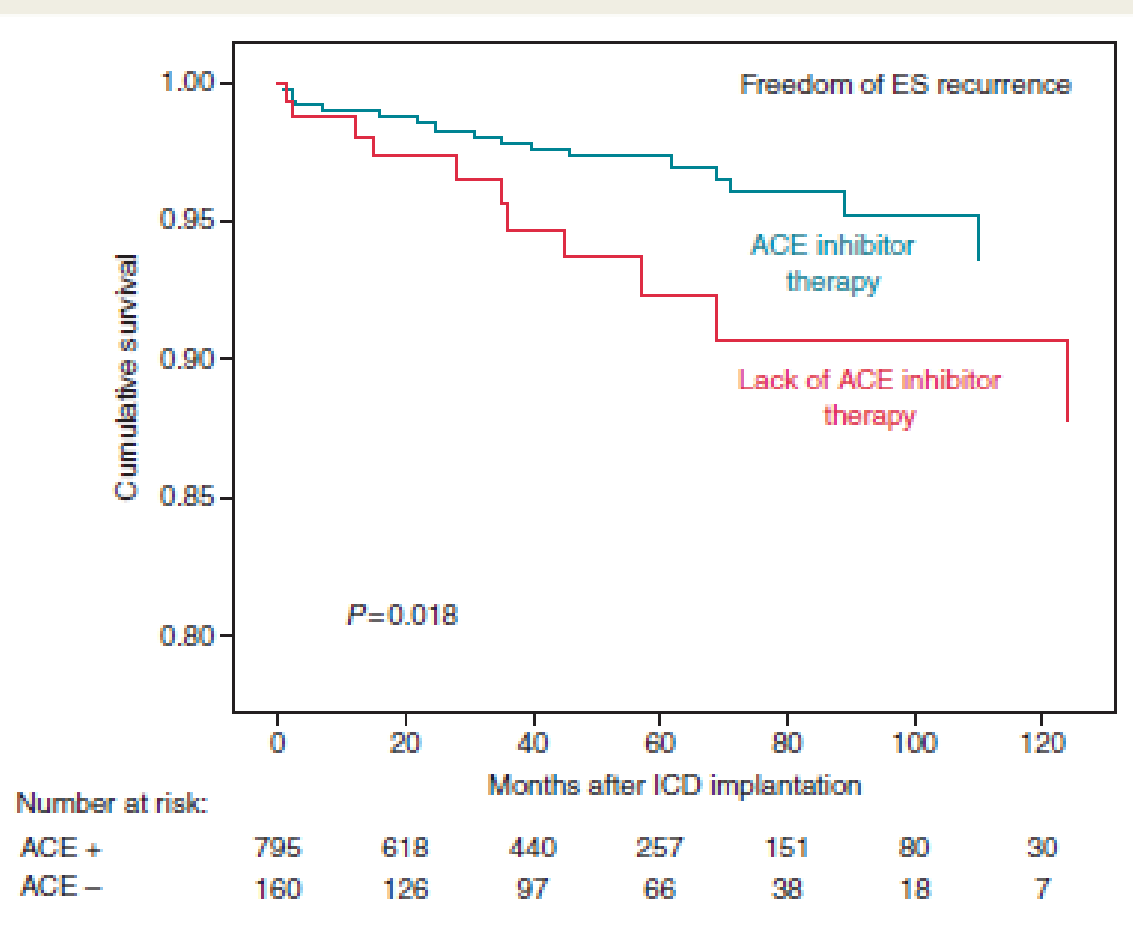
Follow-up 54±35 months

63/955 patients with ES (6.6%)

Streitner et al. Europace 2011; 13: 668-774

Management of electrical storm

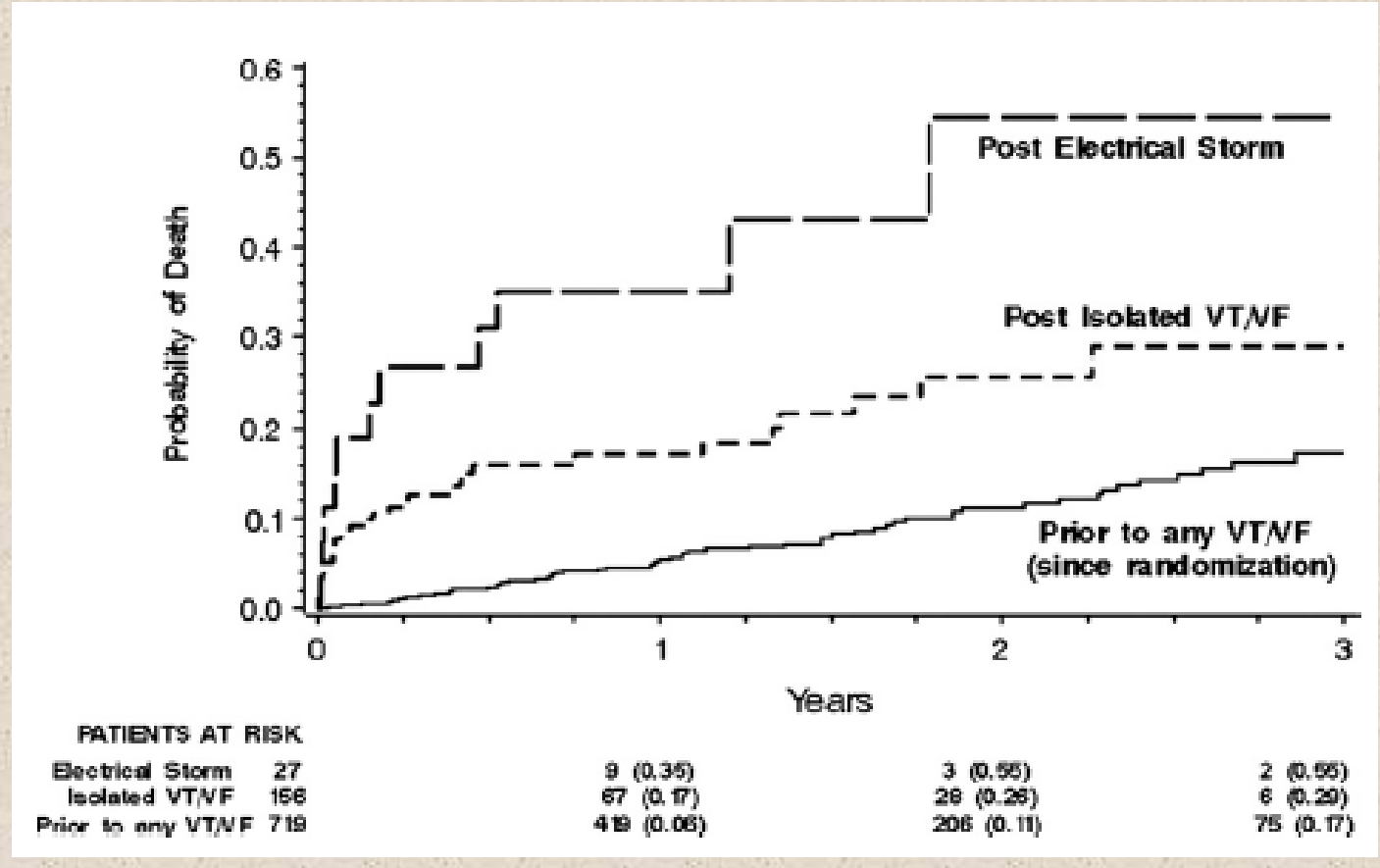
ES recurrences according to patients with or without angiotensin converting enzyme inhibitor therapy



Streitner et al. Europace 2011; 13: 668-774

Management of electrical storm

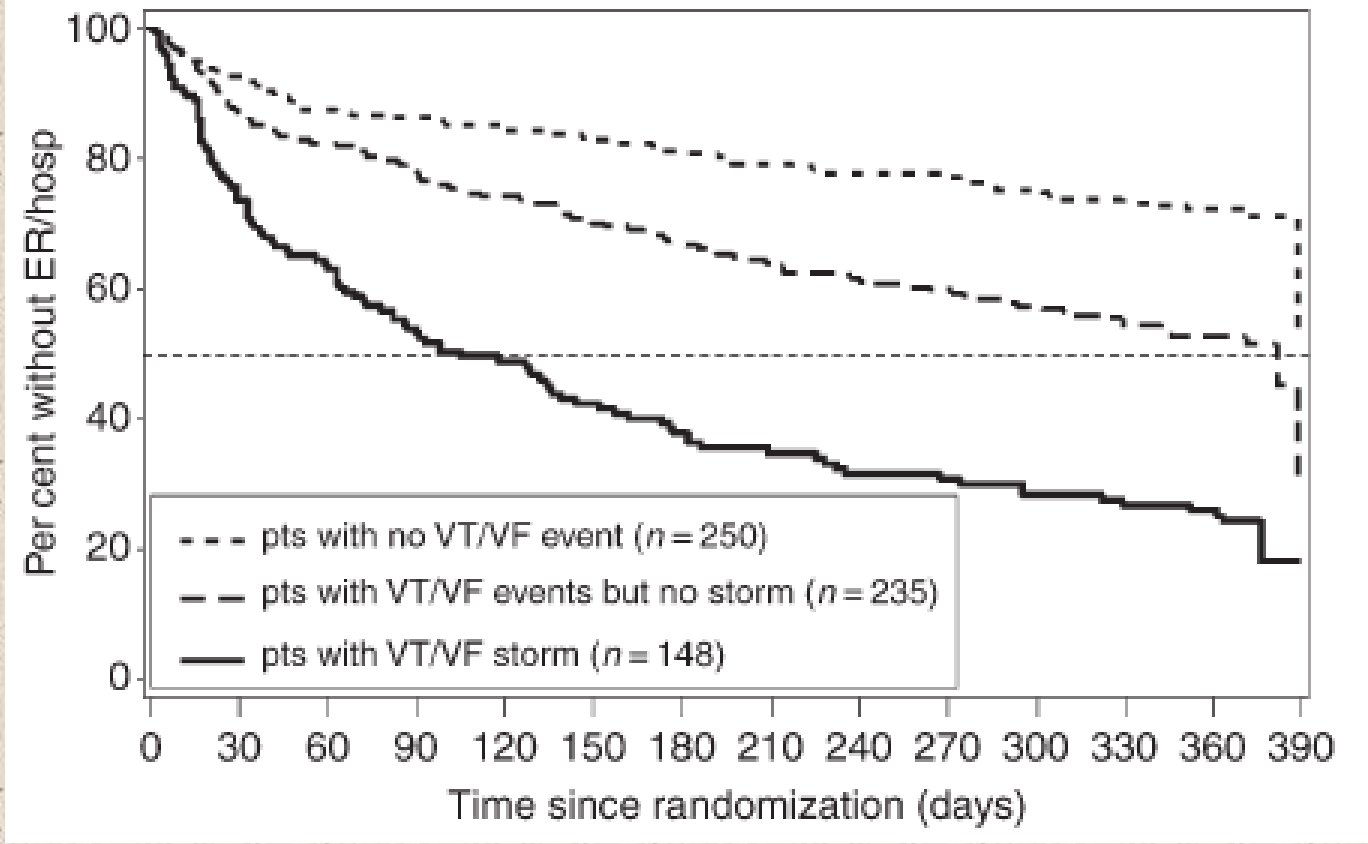
Electrical storm in MADIT-II



Huang et al. Heart Rhythm 2007; 4: 1395-1402

Management of electrical storm

Electrical storm in SHIELD



Hohnloser et al. Eur Heart J 2006; 27: 3027-3032

Electrical storm – clinical approach

- **electrical stability**
  - stable
  - unstable
- **hemodynamic stability**
  - tolerable
  - untolerable

- **configuration of QRS**
  - monomorphic
  - polymorphic
- **morphology**
  - TdP
  - QRS discernible
  - VF

Management of electrical storm

Ischemia (exercise)	arrhythmogenic substrate (at rest)
➢ no prior infarction	➢ infarction
➢ VF, polymorphic VT	➢ monomorphic VT
➢ significant coronary lesion (main stem)	➢ occluded coronary vessel

Early Repolarization Syndrome

Lambda-like ST segment elevation in acute myocardial infarction – a new risk marker for ventricular fibrillation? Three case reports

Uniesienie odcinka ST o kształcie litery lambda w ostrej fazie zawału serca – nowy wskaźnik ryzyka wystąpienia migotania komór? Opis trzech przypadków

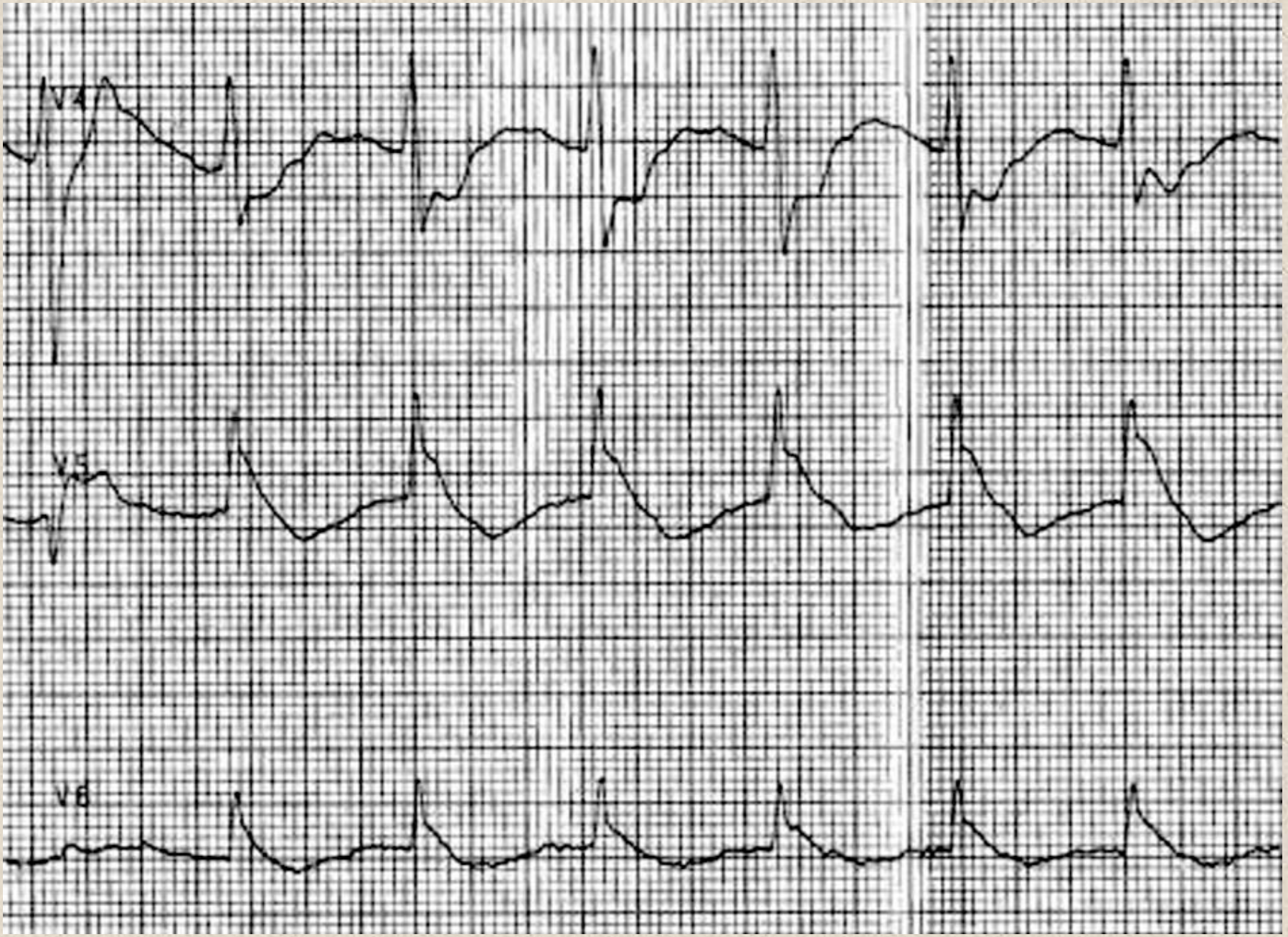
Piotr Kukla[1], Marek Jastrzębski[2], Jerzy Sacha[3], Leszek Bryniarski[2]

[1] The H. Klimontowicz Hospital, Gorlice
[2] 1st Departament of Cardiology, *Collegium Medicum*, Jagiellonian University, Kraków
[3] Department of Cardiology, Medical Center, Opole

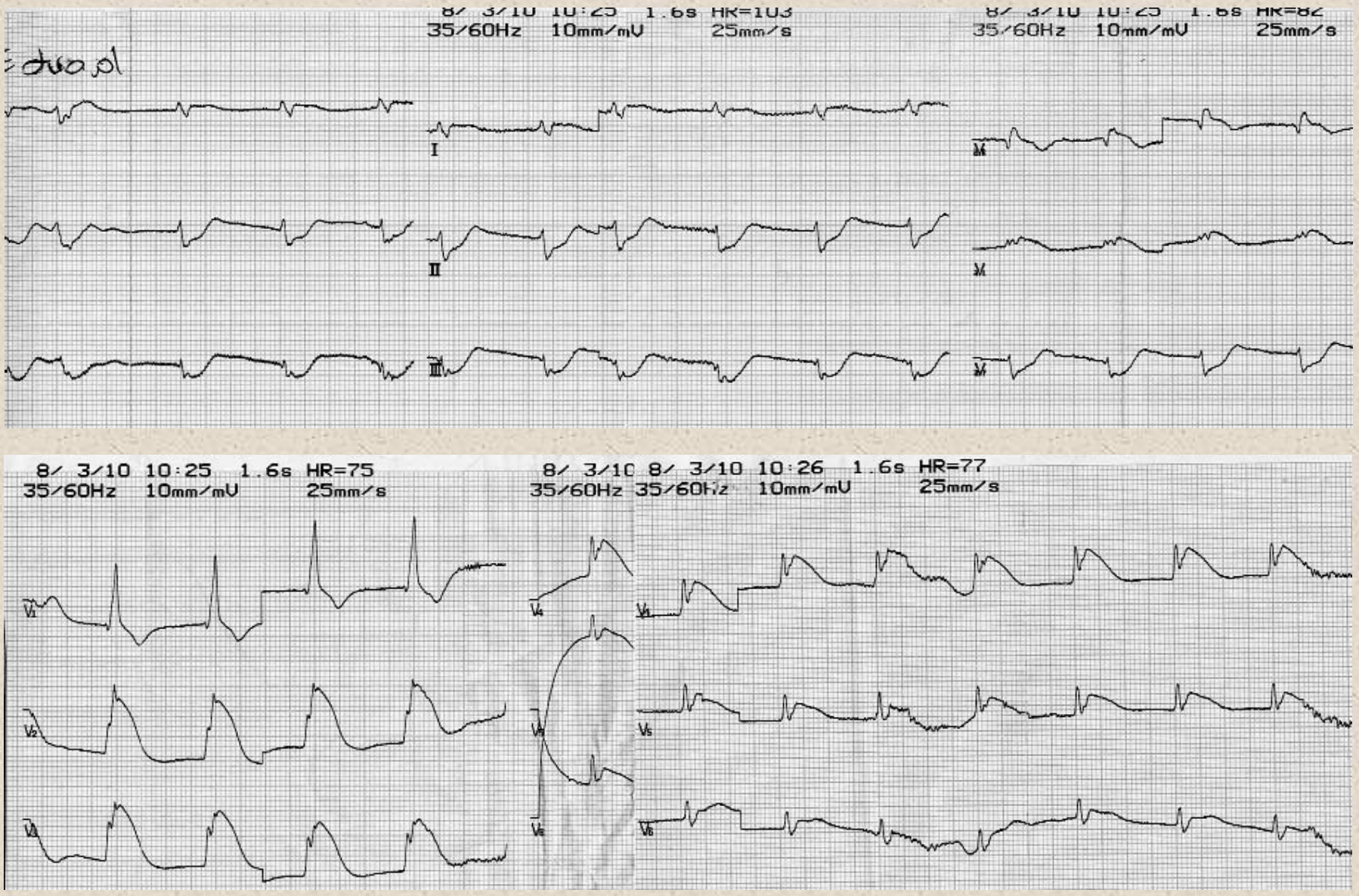
Kardiol Pol. 2008;66:873-7

Abstract

Sudden cardiac death (SCD) is responsible for almost 50% of all cardiac deaths in the U.S. The most common cause of SCD is coronary artery disease, especially during acute myocardial infarction (AMI). There are no publications concerning the shape of ST segment elevation in AMI and the risk of ventricular fibrilation (VF) or SCD. We present three cases with AMI and atypical ST segment elevation – lambda-wave-like complicated with episodes of VF.


V4
V5
V6

Early Repolarization Syndrome



Management of electrical storm

Potential causes (I)

- **slowing of conduction**
  (SR → VT)
- **recurrent ischemia**
- **intoxication / multiple antiarrhythmic drugs**

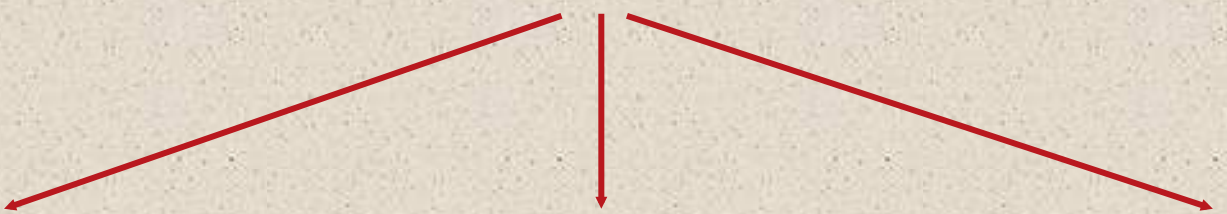
Management of electrical storm

Potential causes (II)

- **electrolyte disturbance**
- **progression of CHF**
- **alcohol, stress**
- **mechanically induced VT**
  (temporary pacing lead)

Management of electrical storm

Acute management



Monomorphic VT

Polymorphic VT / VF

TdP

Management of electrical storm

Monomorphic VT (I)

- cardioversion (J↓)
- overdrive pacing
- electrolyte administration
- Mg^{++}

Management of electrical storm

Monomorphic VT (II)

- sedation / narcosis
- (Betablocking agents, esmolol iv)
- overdose of antiarrhythmic drugs

  Na^+ lactate i.v.

  rate ↗ (class III, AA)

  rate ↙ (class I, AA)

  CPR until drug elimination

Management of electrical storm

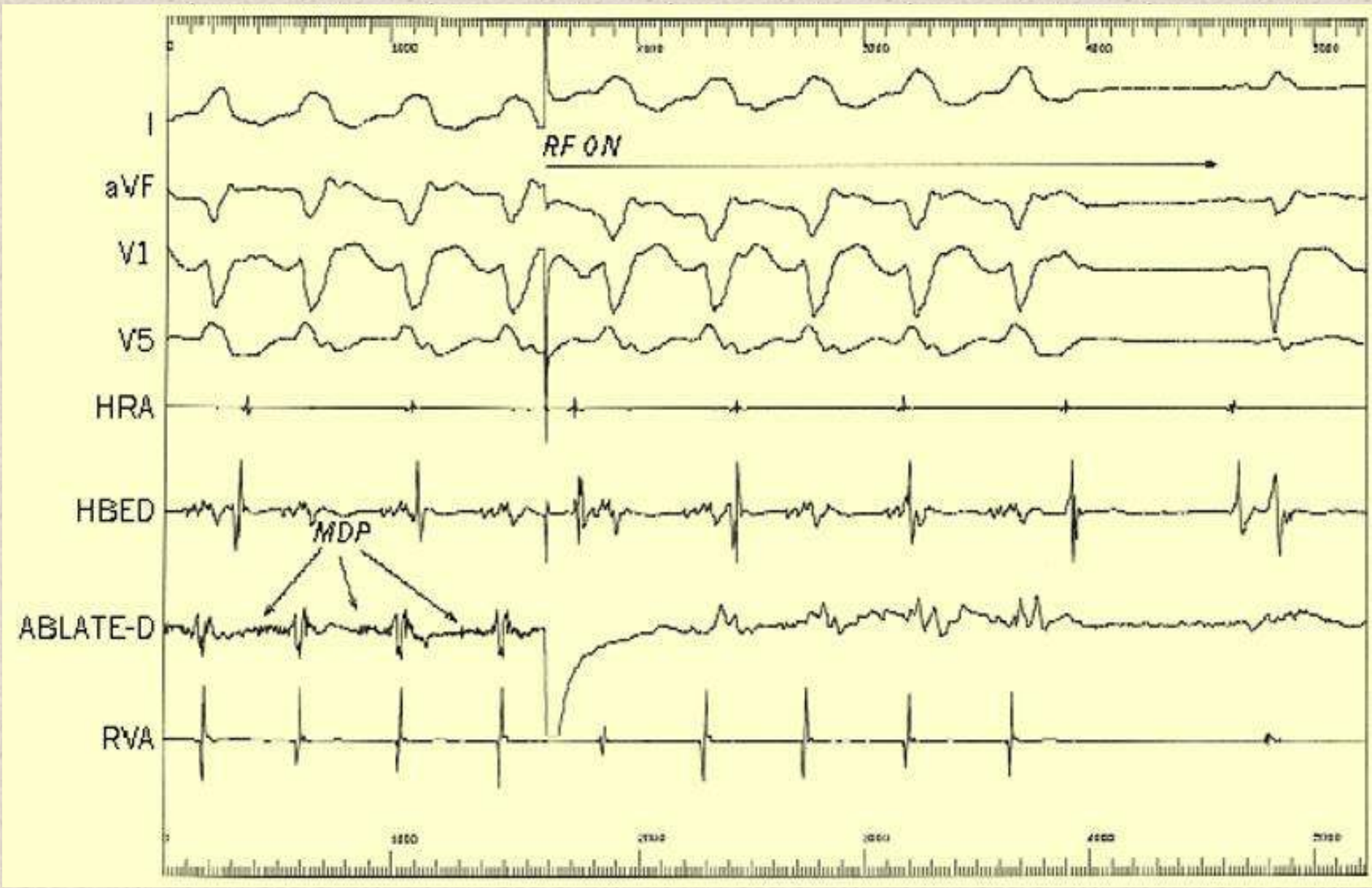
Monomorphic VT (III)

- **treatment of CHF**
  (catecholamine, diuretics, hemofiltration)
- **exclude ongoing ischemia → angiography**
- **amiodarone i.v (5 mg/kg – 5 min)**

⟹ **Catheter ablation**

(TTE/TEE → exclude thrombus formation)

Termination of incessant VT during RF ablation



Management of electrical storm

Unstable VT / VF

- IAPP
- ECMO

→ Stabilize circulation

→ Emergency ablation

Management of electrical storm

Stabilisation of medically refractory ventricular arrhythmia by intra-aortic balloon counterpulsation

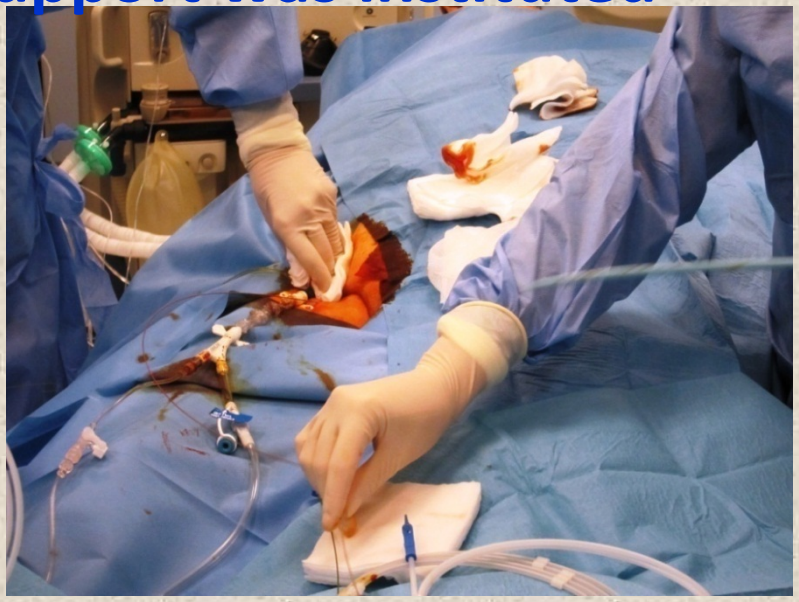
G D Fotopoulos, M J Mason, S Walker, N S Jepson, D J Patel, A G Mitchell, C D J Ilsley, V E Paul

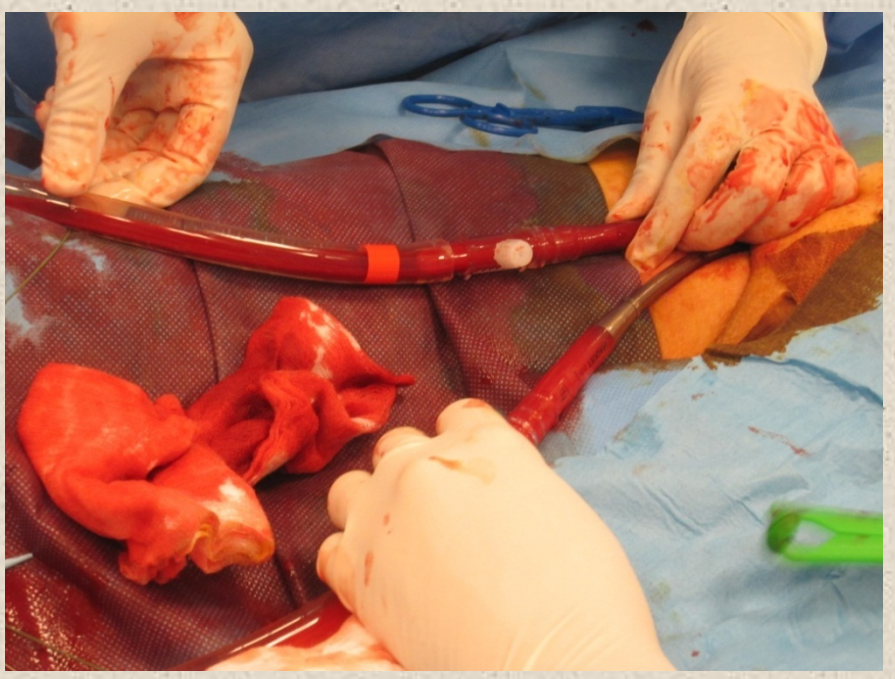
Heart 1999; 82: 96-100

- **IABP is an effective support to achieve pts stabilization before the treatment of the arrhythmia by catheter ablation.**
- **It allows extensive treatment with even in patients with severely depressed LV function.**

Management of electrical storm

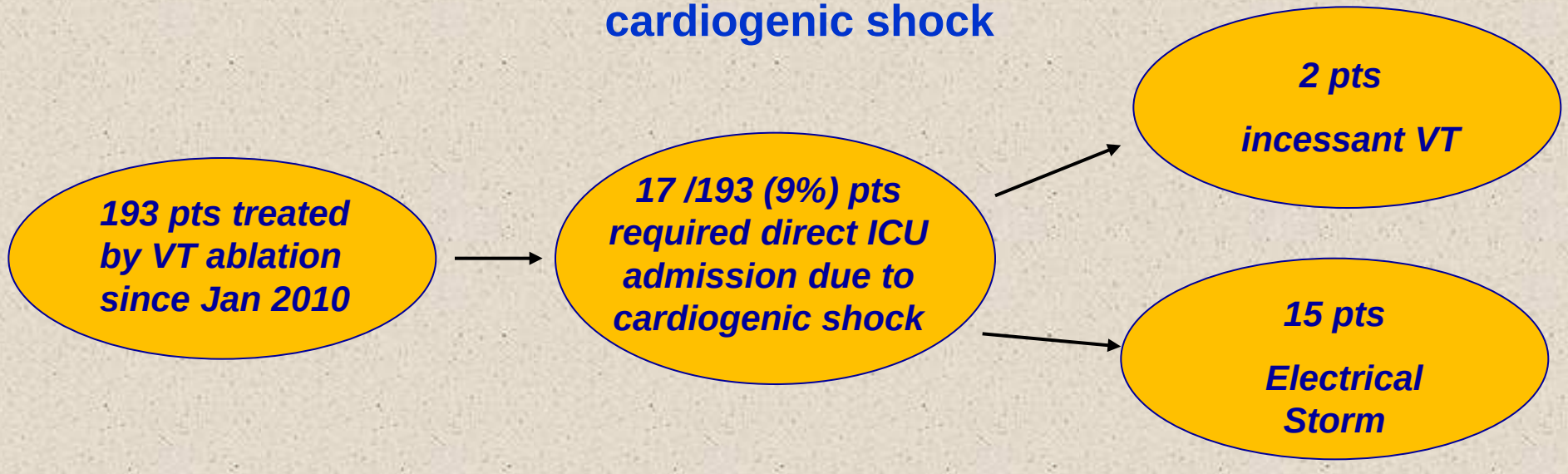
ECMO hemodynamic support was instituted





Management of electrical storm

Patients with recurrent Ventricular Tachycardia presenting cardiogenic shock



CAD	11 /17 (65%)
IDCM	5 / 17 (29%)
ARVD	1 / 17 (6%)

ECMO	3 /17 (18%)
IABP	14 / 17 (82%)

Age, Mean ± SD, Years	68 ±10
LVEF	28 ±6
Unresponsive to chronic Amiodarone	11 / 17 (65%)
Unresponsive to ev lidocaine	15 /17 (88%)
Renal Disease , N, %	5 /17 (29%)
AFib , N, %	9 / 17 (53%)
ICD , N, %	14 /17 (82%)

Della Bella, Milan Experience

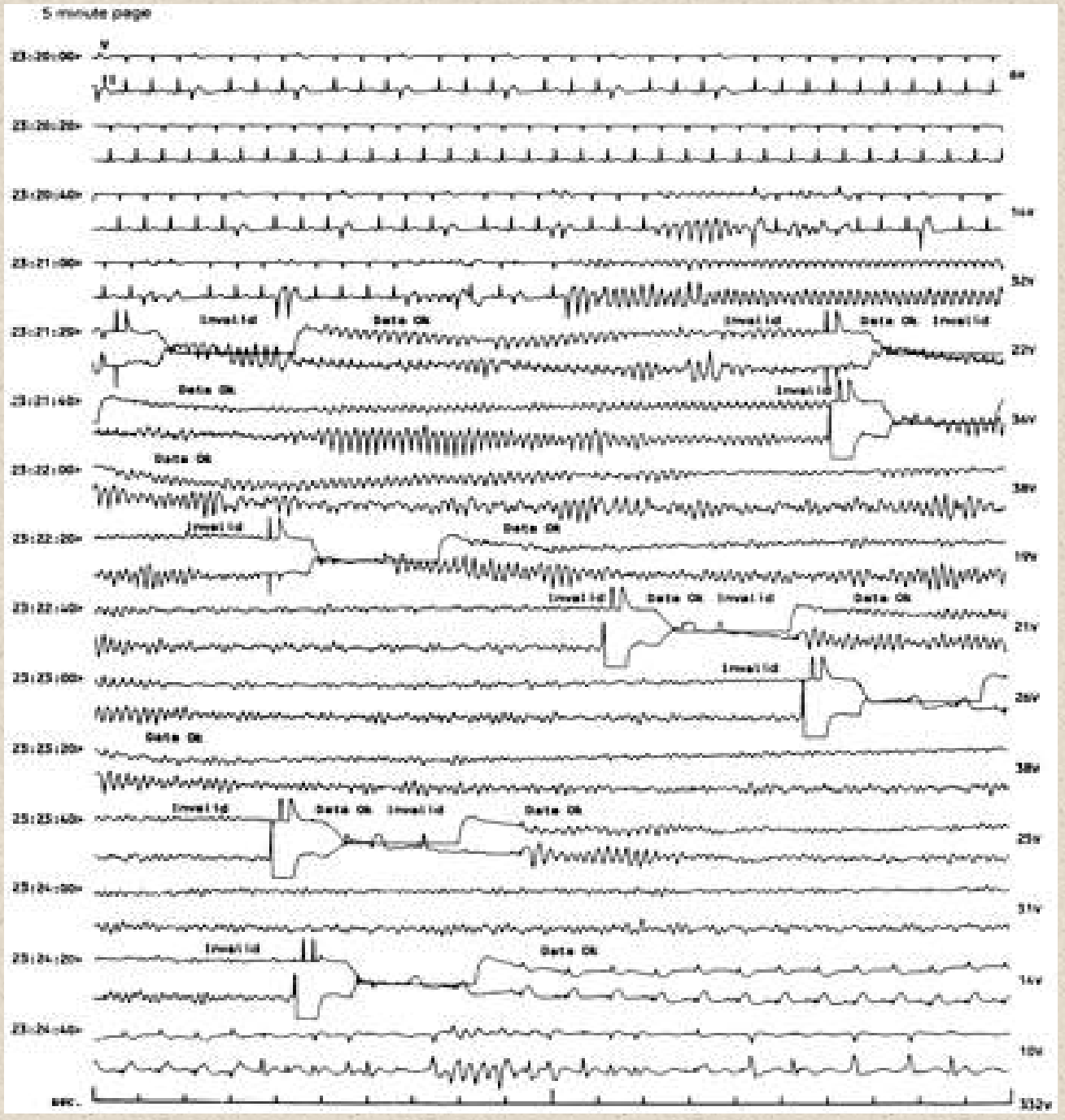
Management of electrical storm

Catheter ablation

Number of ablation procedures		
	1	*16/17 (94%)*
	2	*1/17 (6%)*
Mapping system		
	CARTO	*12/17 (70%)*
	Navx- Non contact Array	*5/17 (30%)*
Ablation Site		
	Endocardial	*12/ 17 (70%)*
	Endo-Epicardial	*5 / 17 (30%)*
Late potentials abolition		*9/17 (53%)*
Post-procedural EP study		*10 /17 (58%)*
	Prevention of any VT induction	*9/17 (52%)*
	Induction of VF	*1/17 (6%)*

Stable hemodynamically efficient sinus rhythm was achieved in all patients.

Della Bella, Milan Experience



Recurrent VF

Nademanee et al,
Circulation 2000;102:3080

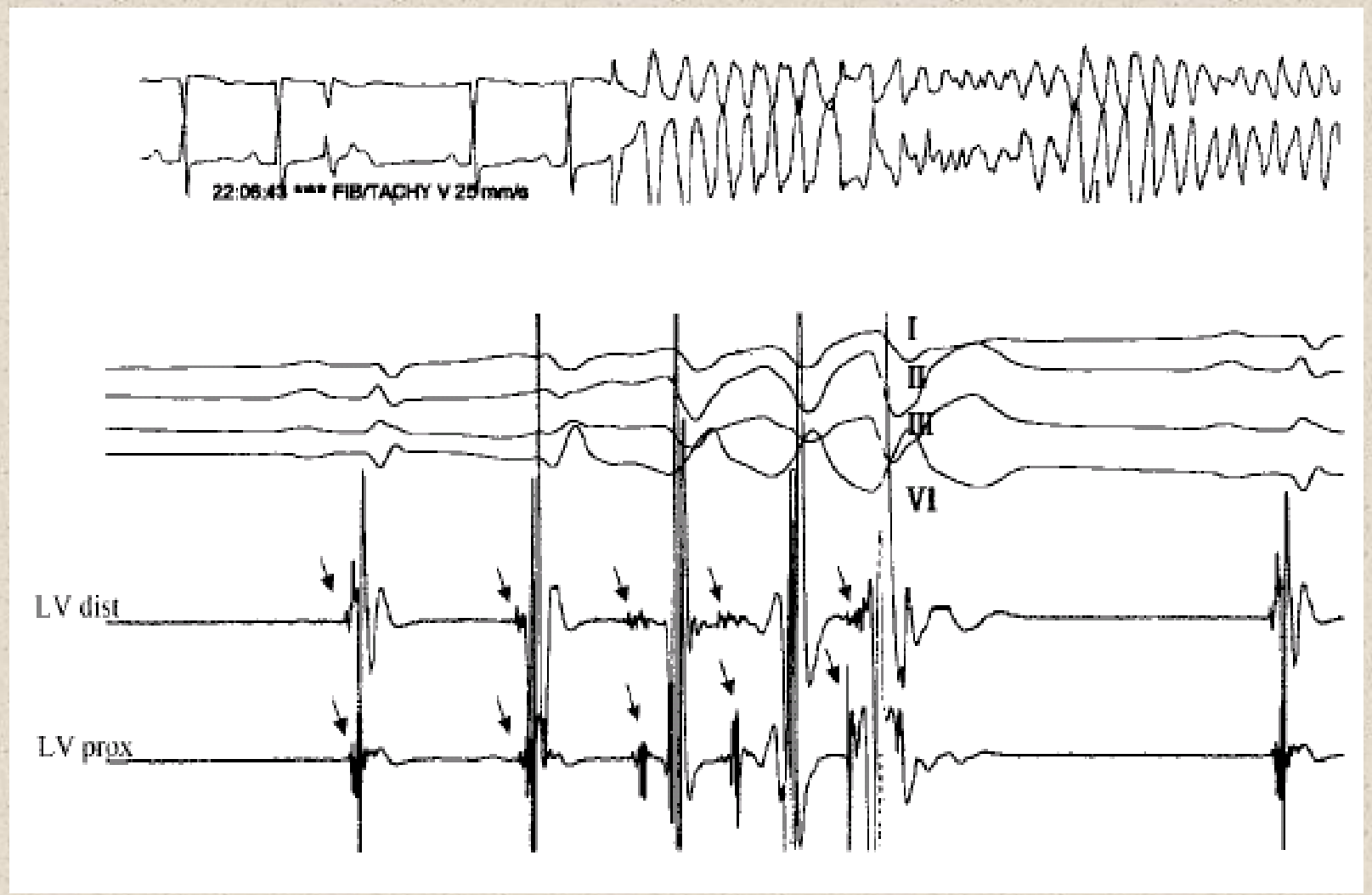
Management of electrical storm

Polymorphic VT / VF

Acute management

- **defibrillation**
- **recurrent ischemia ?**
- **amiodarone i.v., betablocker i.v.**
- **Mg^{++} sulfate i.v.**
- **emergency angiography**
  (PTCA, CABG)
- **bradycardia induced?**
  catecholamine, temporary pacing
- **emergency ablation**

Mapping and ablation of idiopathic VF



Haïssaguerre et al, Circulation, 2002; 106: 962-967

Mapping and ablation of idiopathic VF

n = 27

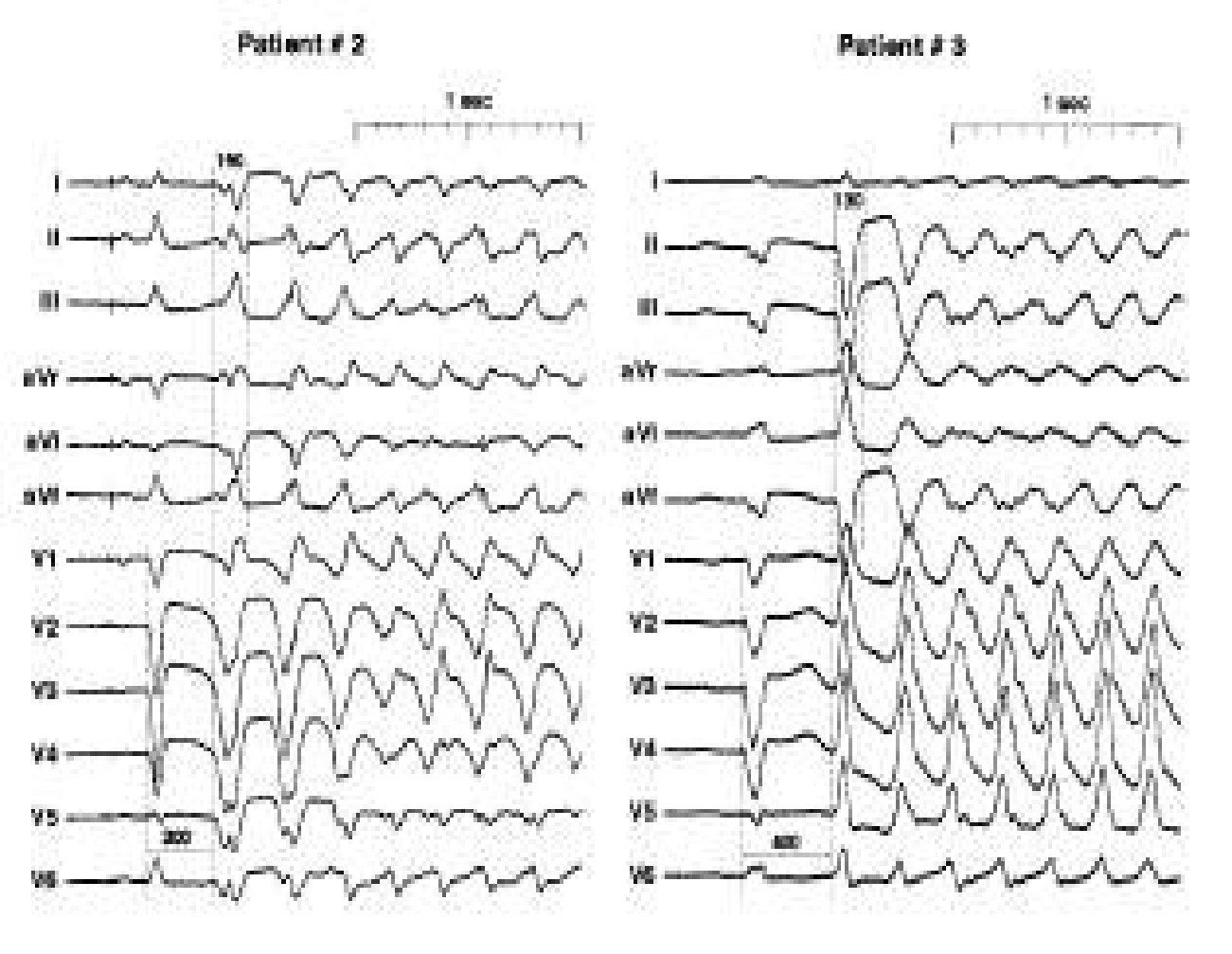
- **HP system** **23 / 27 pts**

left ventricular septum	10 pts
anterior right septum	9 pts
both	4 pts

- **RVOT 4 / 27 pts**

→ **24 ± 28 months** **89% no VF** (ICD back-up)

Ablation of polymorphic VT/VF after MI



Bänsch et al. Circulation 2003; 108: 3011-3016

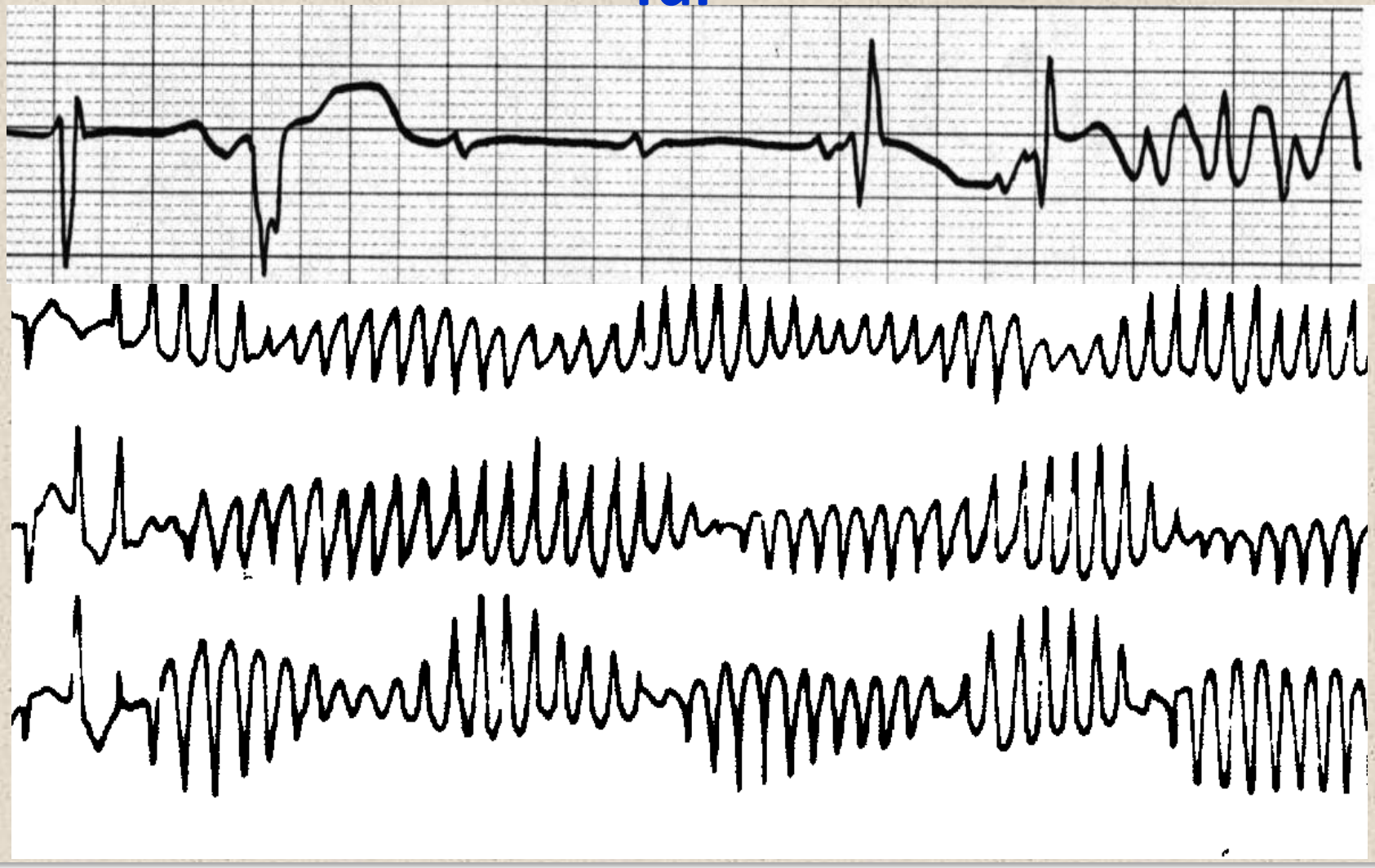
Ablation of VT/VF

Conclusions

- **Ablation of unstable VT is possible**
  - → VT palliation
  - → rescue procedure
- **Ablation of VF is possible**
  - → VF palliation
- **ICD back-up is still mandatory**

Management of electrical storm

TdP



Management of electrical storm

TdP

Acute management

- **increase rate**
  - → **isoproterenol i.v.**
  - → **temporary pacing**
- **betablocker agents i.v.**
  - → **(mexilitine)**
- **Mg^{++} sulfate i.v.**

Management of electrical storm

Electrical storm in J-wave syndromes

- Isoproterenol infusion
- Fever ↓
- Catheter ablation
- Quinidine

Management of electrical storm

Electrical storm in idiopathic VF

n = 91 patients

14/91 pts (15.4%) with ES

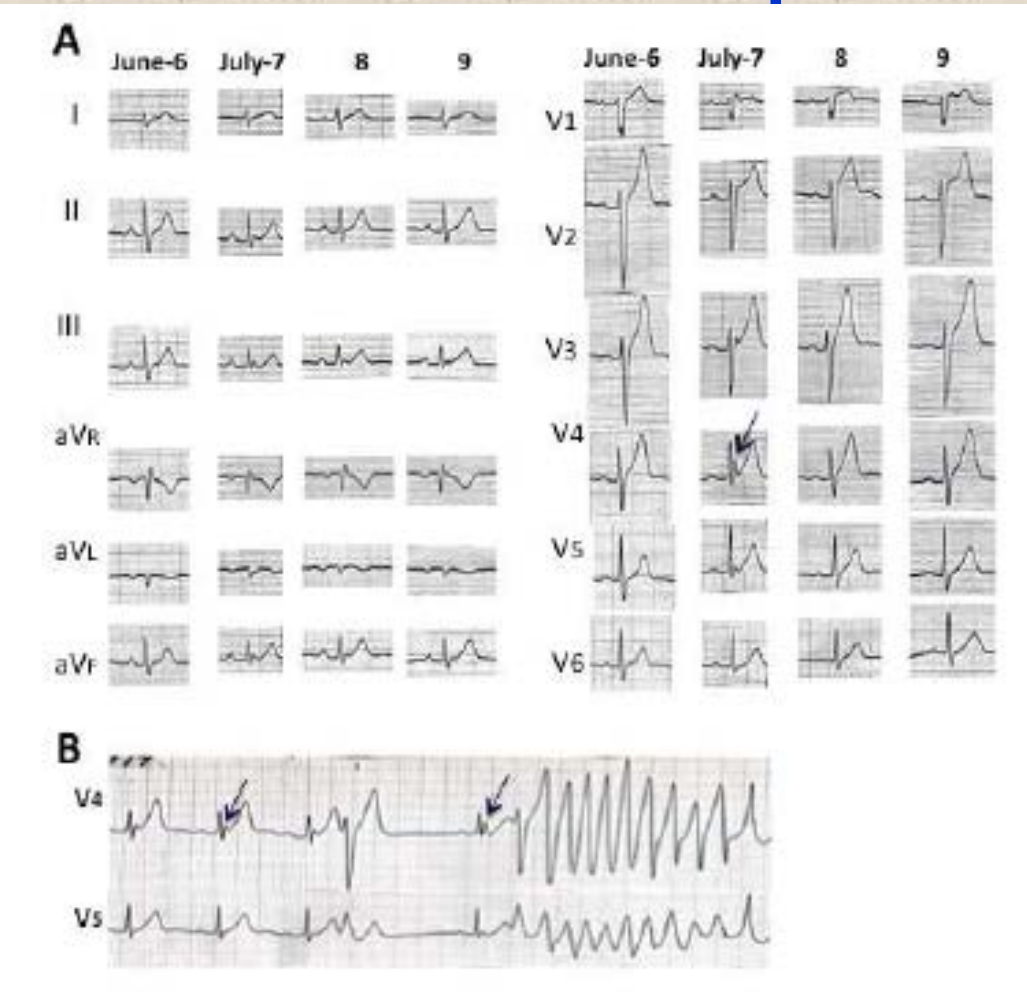
J-wave

no storm (n=77)	ES storm (n=14)
36%	93%

Aizawa et al, JACC 2013; DOI: 10.1016/j.jacc.2013.05.030

Management of electrical storm

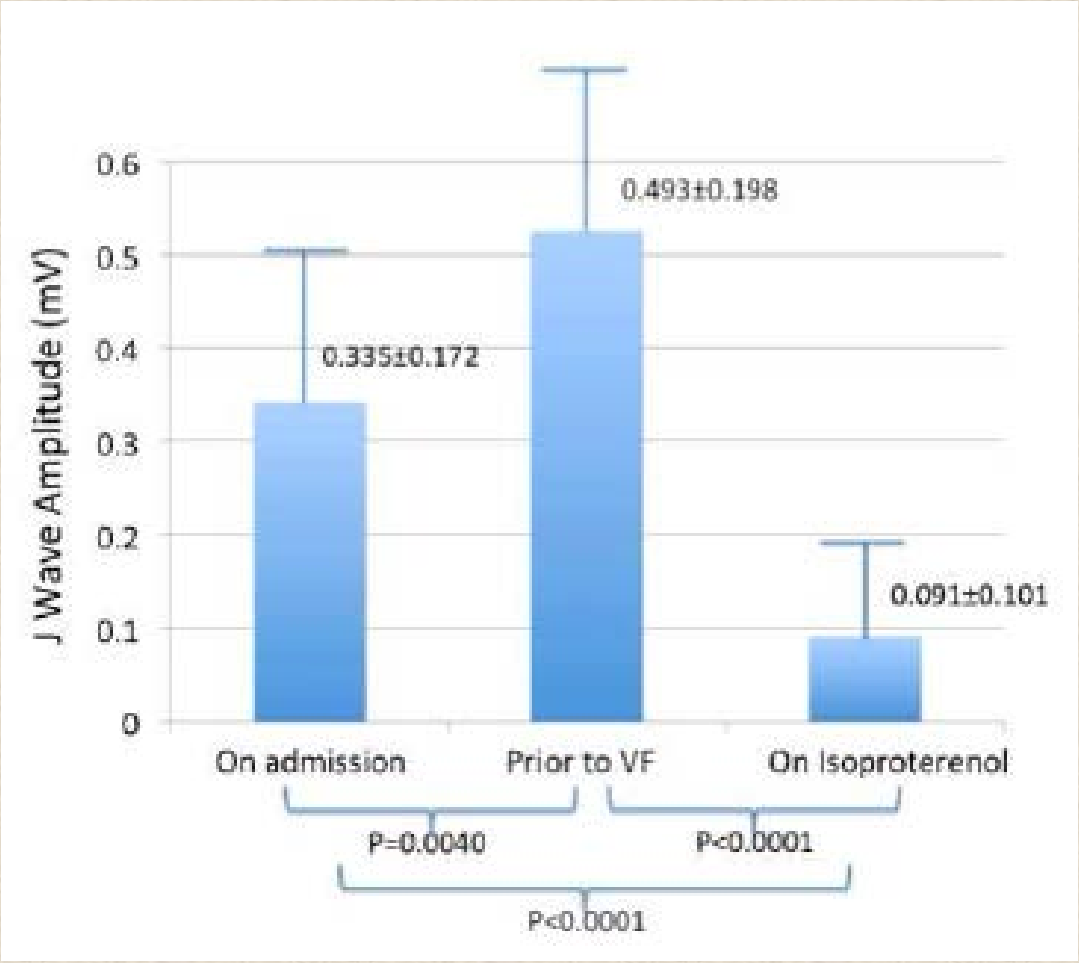
Electrical storm in idiopathic VF



Aizawa et al, JACC 2013; DOI: 10.1016/j.jacc.2013.05.030

Management of electrical storm

Effect of isoproterenol in electrical storm



Aizawa et al, JACC 2013; DOI: 10.1016/j.jacc.2013.05.030

Management of electrical storm

Conclusions

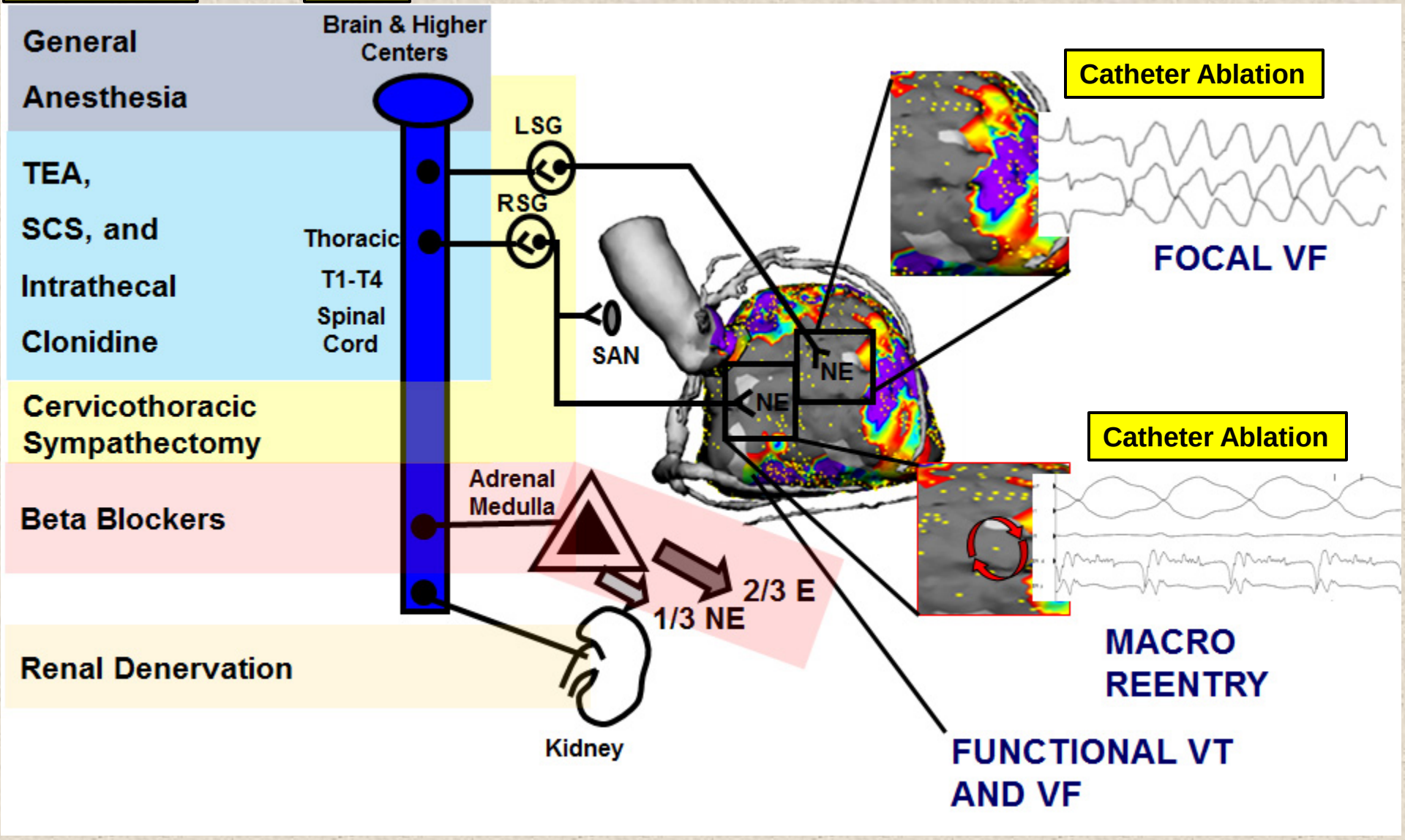
- Electrical storm is a life-threatening condition and occurs in up to 10% of ICD patients
- Randomized trials in the management of electrical storm are lacking
- Management of electrical storm is strongly depending on the skills of the arrhythmia service

Management of VT/VF Storm

Neuraxial and Systemic

At the level of the heart

Intervention	Level
General Anesthesia	Brain & Higher Centers
TEA, SCS, and Intrathecal Clonidine	Thoracic T1-T4 Spinal Cord
Cervicothoracic Sympathectomy	
Beta Blockers	Adrenal Medulla
Renal Denervation	Kidney



THINGS ARE NOT ALWAYS WHAT THEY SEEM

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Universitätsklinikum Mannheim

Basic Res Cardiol (2013) 108:336
DOI 10.1007/s00395-013-0336-2

REVIEW

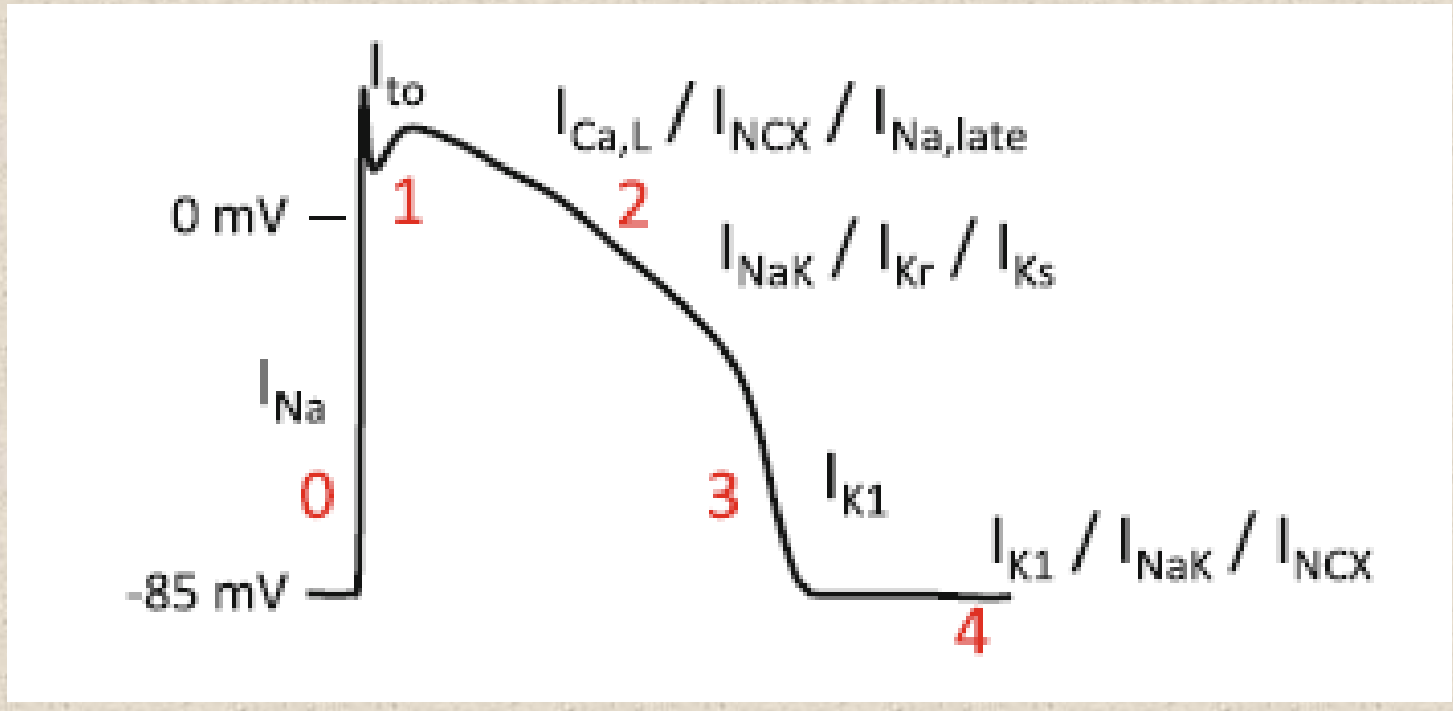
Electrical storm: recent pathophysiological insights and therapeutic consequences

Yukiomi Tsuji · Jordi Heijman · Stanley Nattel · Dobromir Dobrev

Basic Res Cardiol 2013; 108;336

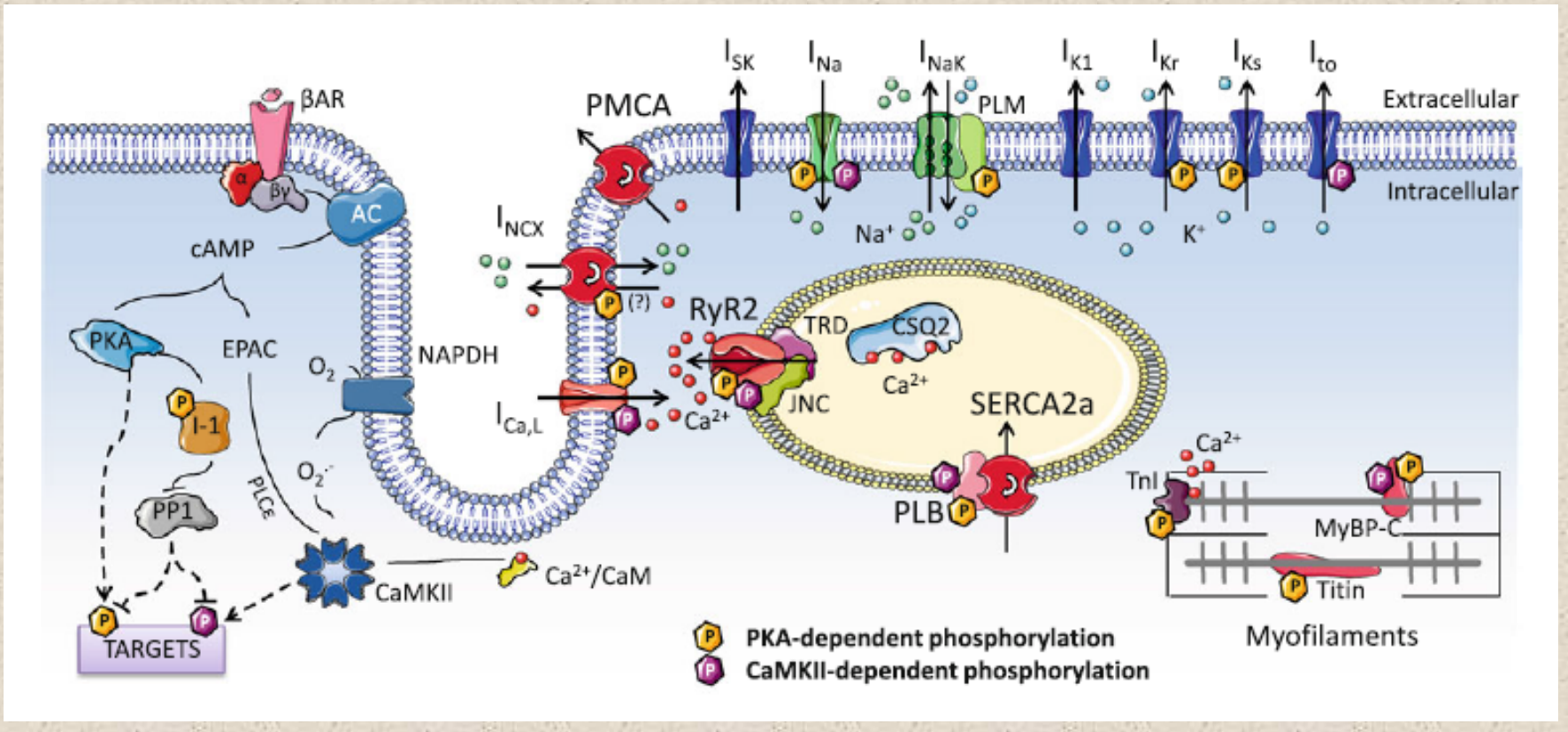
Electrical storm

Prototype of the cardiac action potential (AP) and its underlying ionic currents



Electrical storm

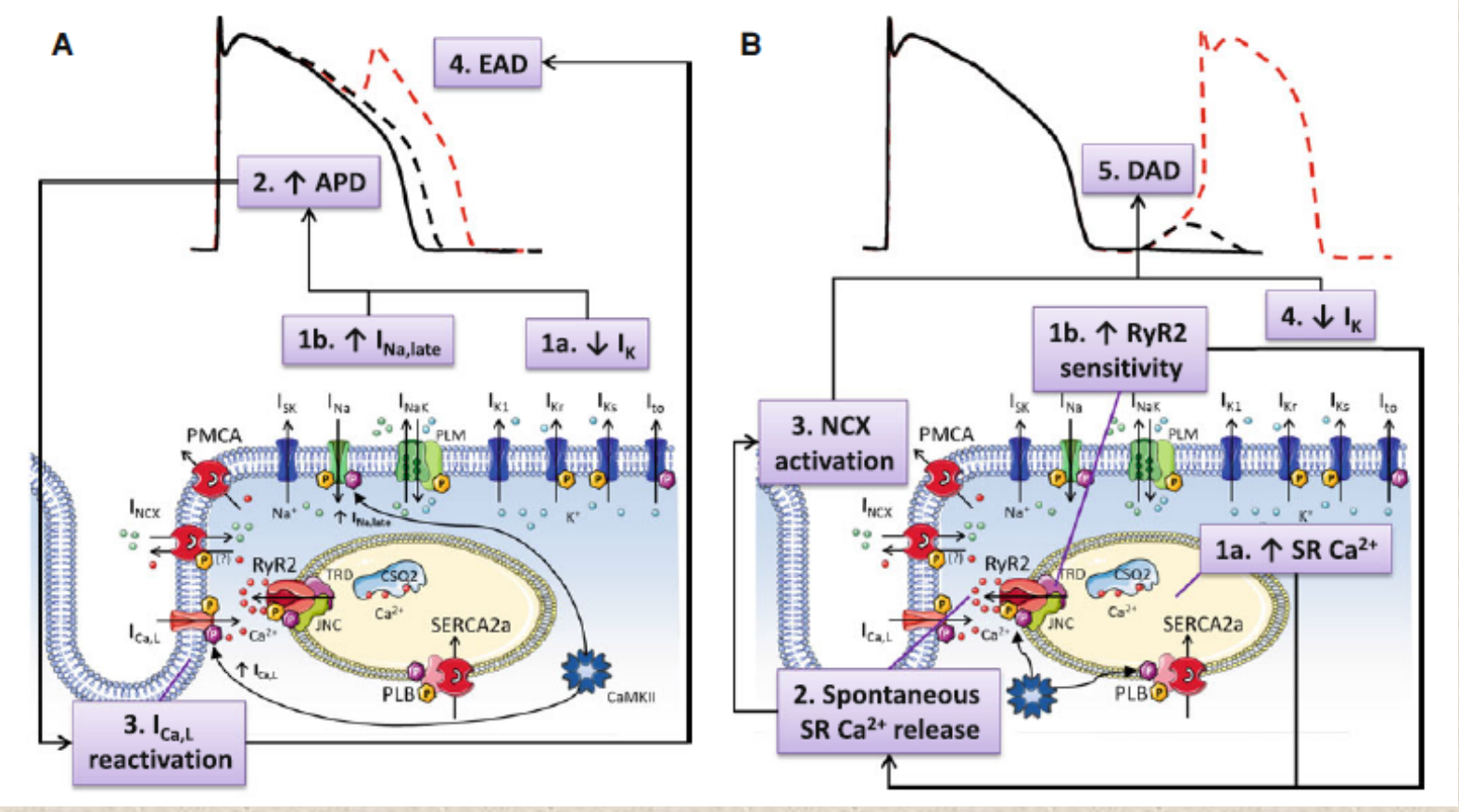
Schematic representation of a ventricular myocyte indicating the major ionic currents



Tsuji et al. Basic Res Cardiol 2013; 108: 336

Electrical storm

Schematic representations of early (a) and delayed (b) afterdepolarizations and their dominant underlying mechanisms



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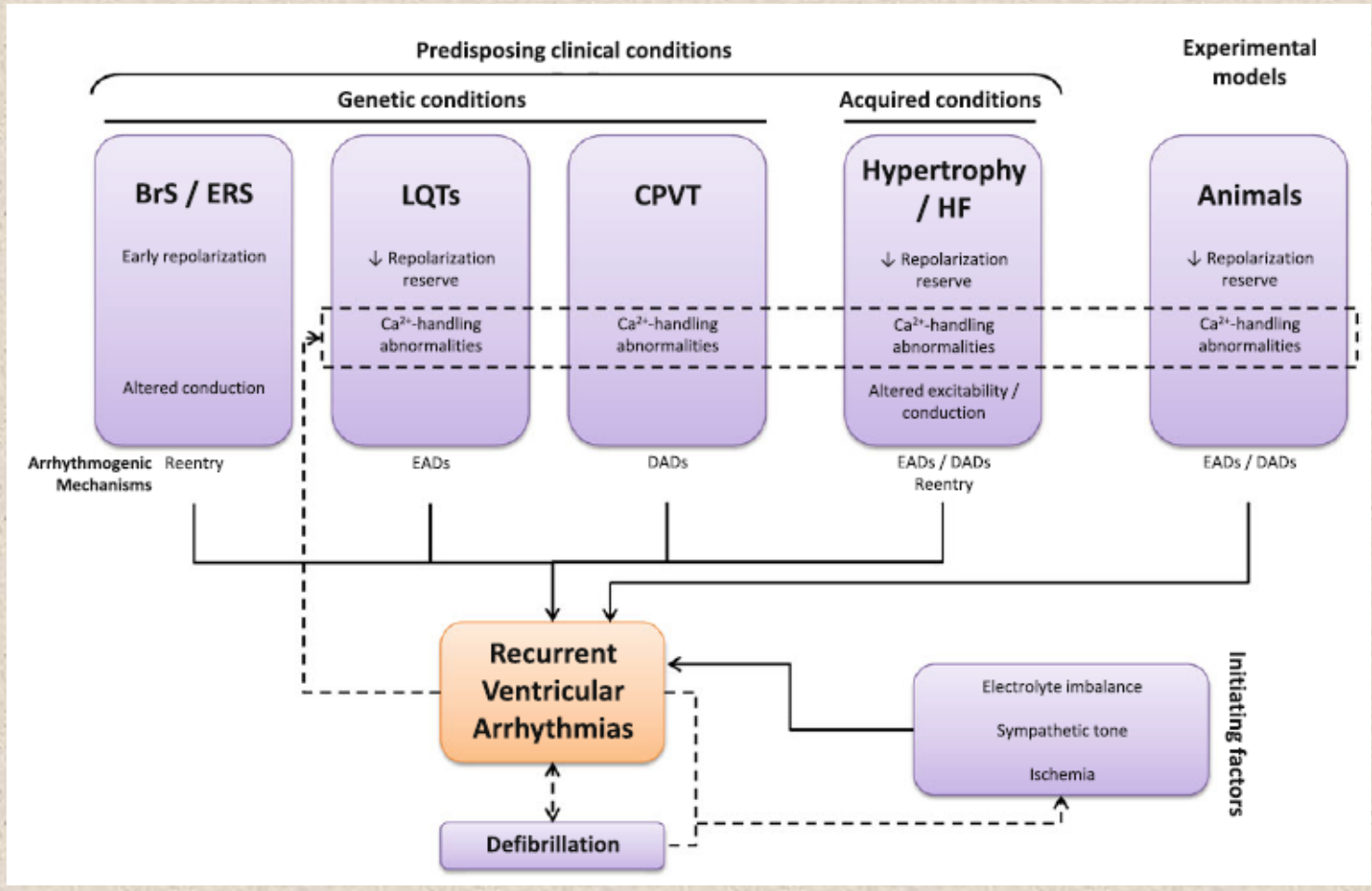
Electrical storm

Overview of clinical conditions



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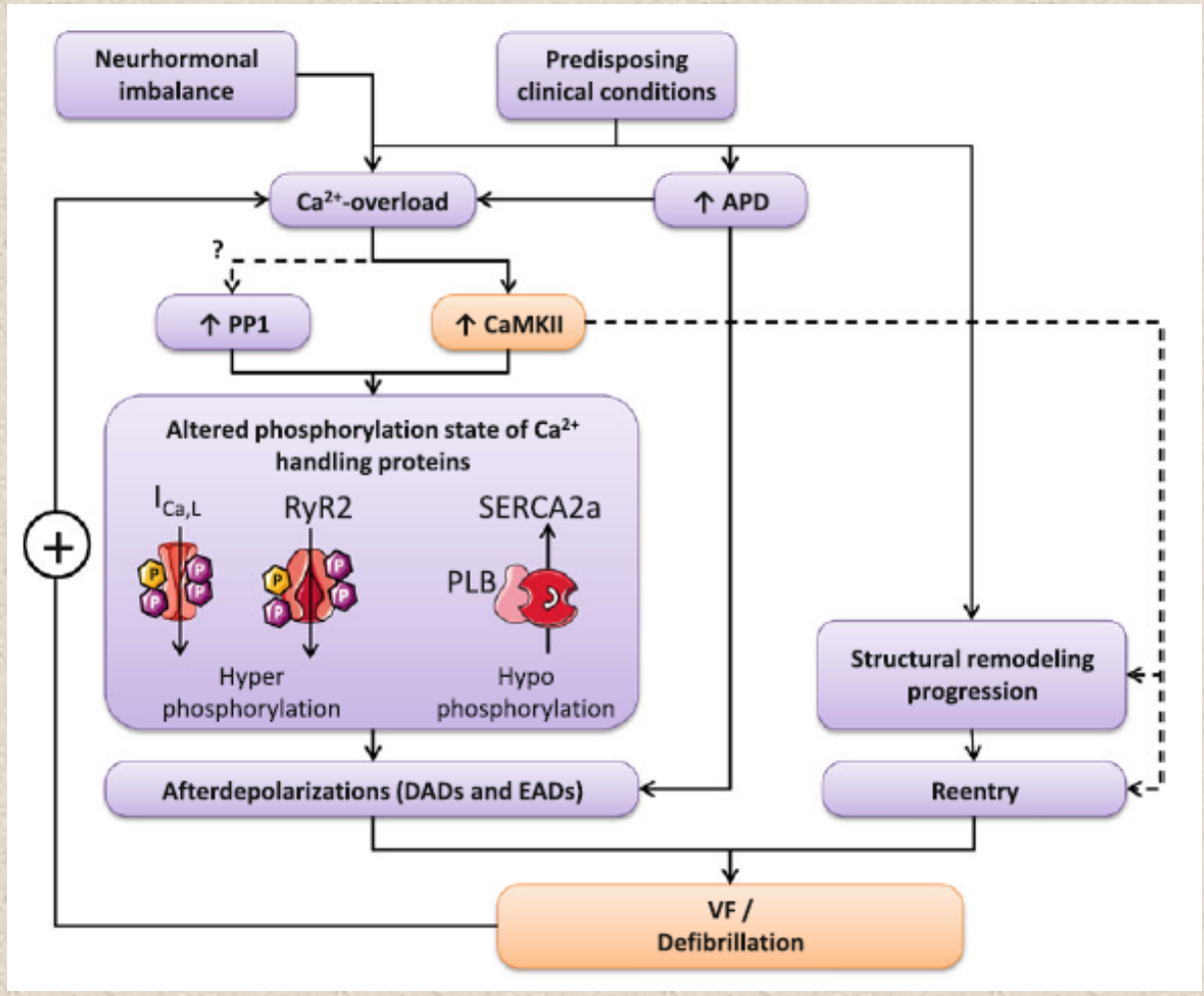
Electrical storm

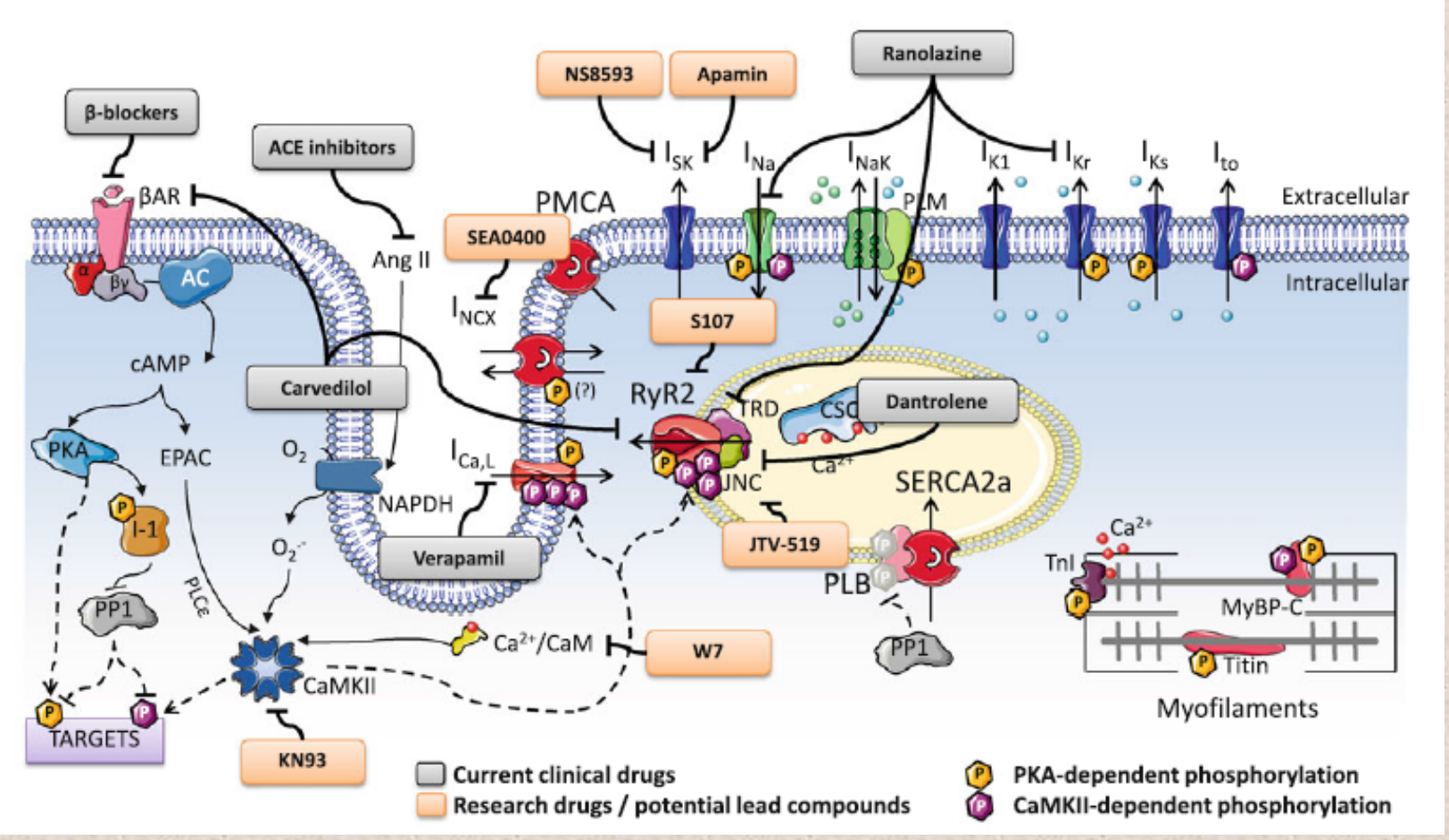
Proposed pathophysiology of ES based on a rabbit ES model.



Tsuji et al. Basic Res Cardiol 2013; 108: 336

Electrical storm

Therapeutic interventions for recurrent VT/VF



Tsuji et al. Basic Res Cardiol 2013; 108: 336