

IL CONTINUUM CARDIOLOGIA D'URGENZA - UTIC PARTE II

Storm aritmico: Cosa fare al DEA e gestione in UTIC

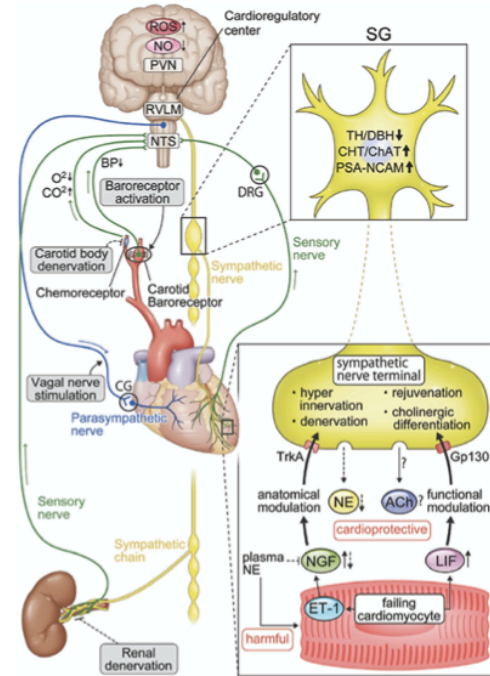
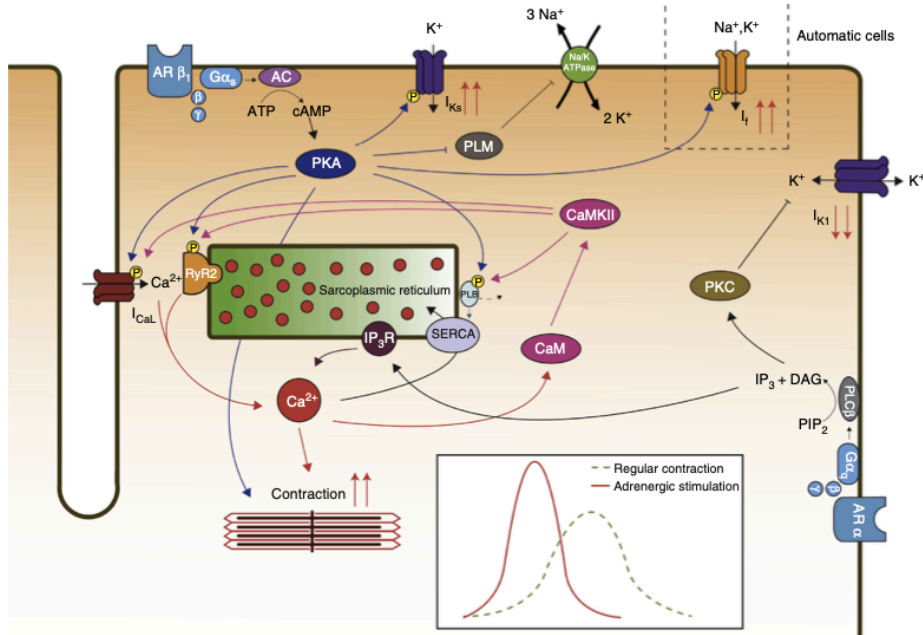
Lanza Oreste

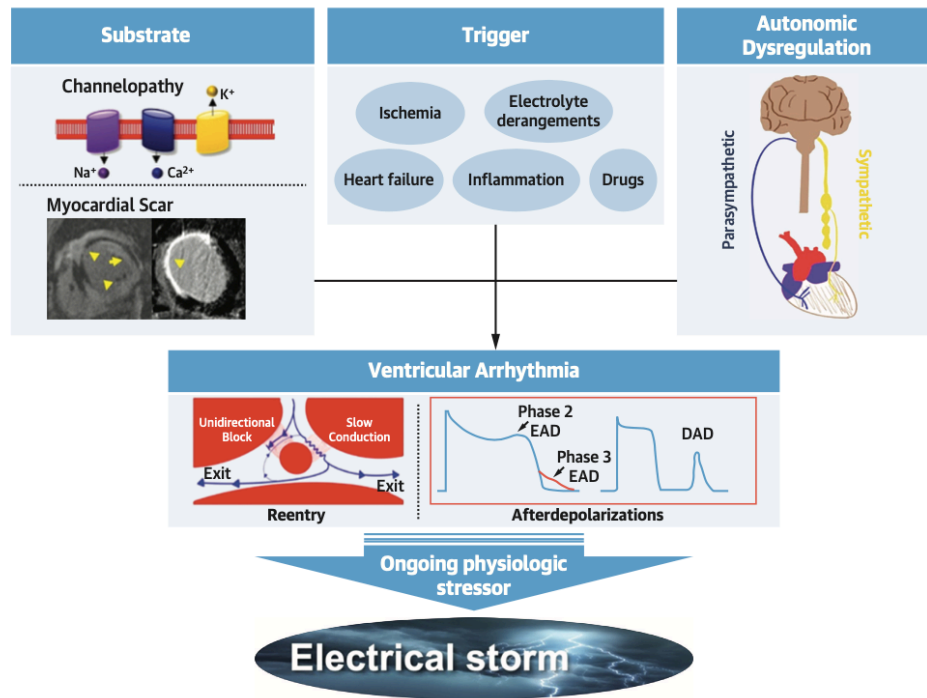


Three or more episodes of sustained VA occurring **within 24 h**, separated by at least **5 min**, each requiring termination by an intervention

Incidence	Presenting arrhythmia	Outcomes
 Primary prev ICD 4–7%	 SMVT 86–97%	 Mortality 3.3 x ↑
Secondary prev ICD 10–30%	 VF 1–21%	
 ICM = NICM 5.8–6.9%/50.9 mo	 SMVT +VF 3–14%	 Re-hospitalization 4.8 x ↑
	PVT 2–8%	







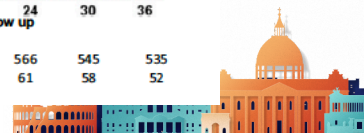
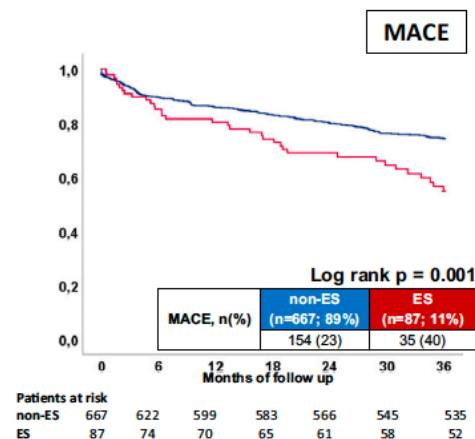
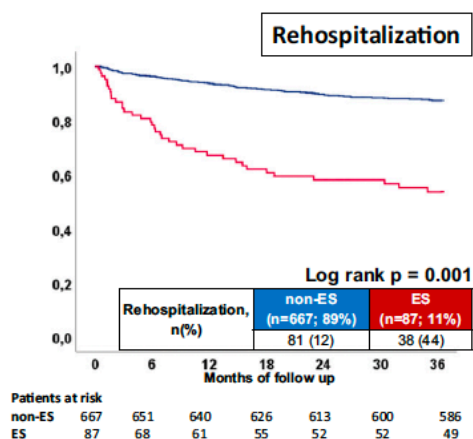
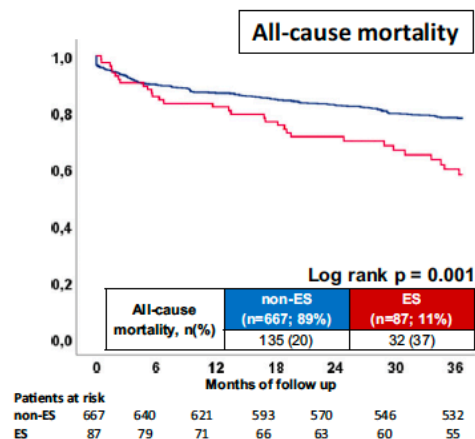
Triggers such as myocardial ischemia, inflammation, or hemodynamic decompensation, as well as drug and electrolyte effects, often with accompanying autonomic nervous system imbalance, can lead to sustained VT caused by re-entry, afterdepolarizations in those with vulnerable anatomic or electrical substrates, including myocardial scar promoting re-entry, EADs from LQTS, or DADs from myocardial ischemia. Perpetuation of the inciting trigger and the resulting SNS response leads to recurrent VT and electrical storm (ES).



Electrical storm is associated with impaired prognosis compared to ventricular tachyarrhythmias



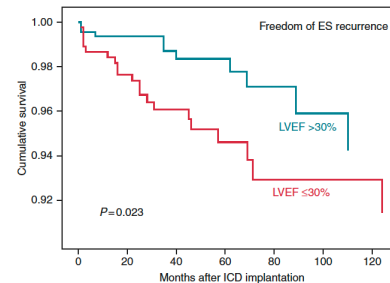
Michael Behnes^{a,*}, Julian Müller^{a,1}, Dominik Ellguth^a, Tobias Schupp^a, Gabriel Taton^a, Linda Reiser^a, Niko Engelke^a, Thomas Reichelt^a, Armin Bollow^a, Seung-Hyun Kim^a, Christian Barth^a, Ahmad Saleh^a, Jonas Rusnak^a, Kathrin Weidner^a, Christoph A. Nienaber^b, Kambis Mashayekhi^c, Muharrem Akin^d, Thomas Bertsch^e, Christel Weiß^f, Martin Borggreve^a, Ibrahim Akin^a



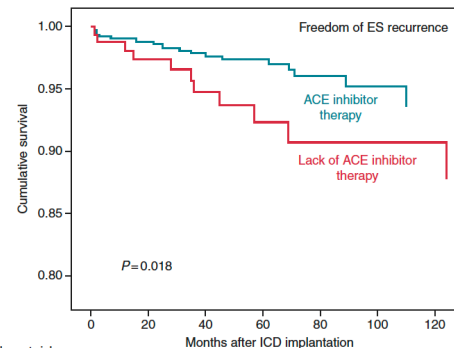
Predictors of electrical storm recurrences in patients with implantable cardioverter-defibrillators

Florian Streitner^{1*†}, Juergen Kuschyk^{1†}, Christian Veltmann¹, Eva Mahl¹, Claudia Dietrich¹, Rainer Schimpf¹, Christina Doesch¹, Ines Streitner¹, Christian Wolpert², and Martin Borggrefe¹

Left ventricular ejection fraction $\leq 30\%$, age 65 years, and a lack of ACE inhibitor therapy are independent predictors of ES-R.

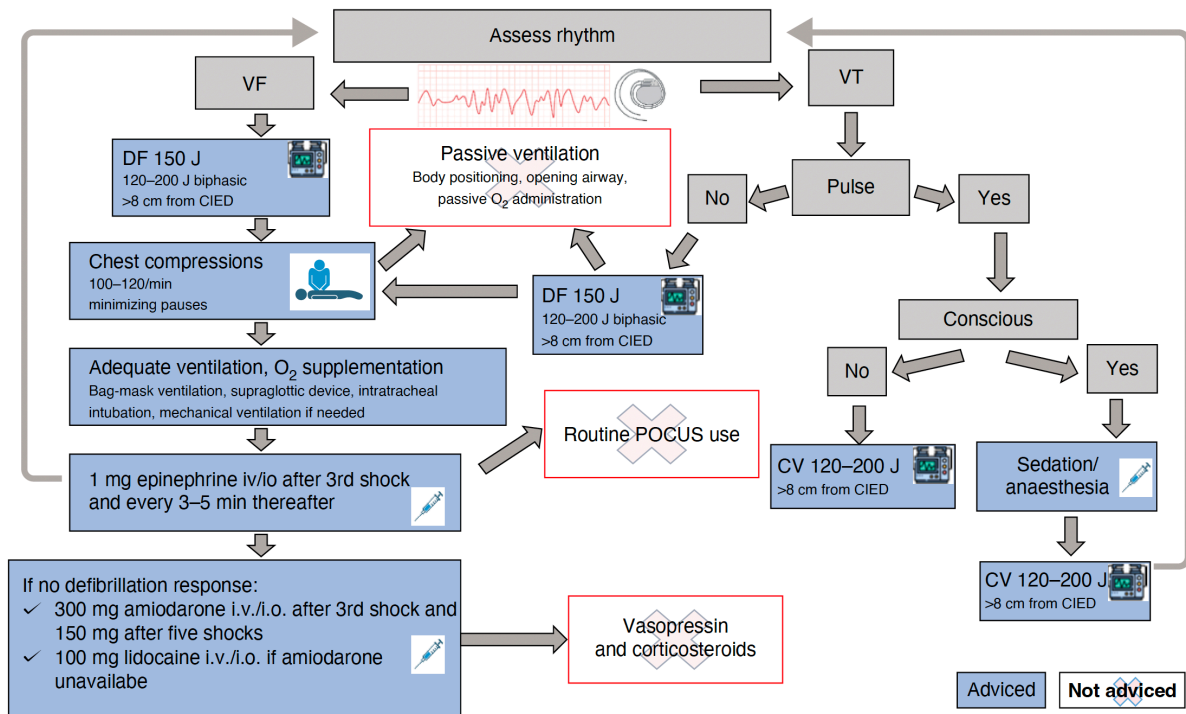


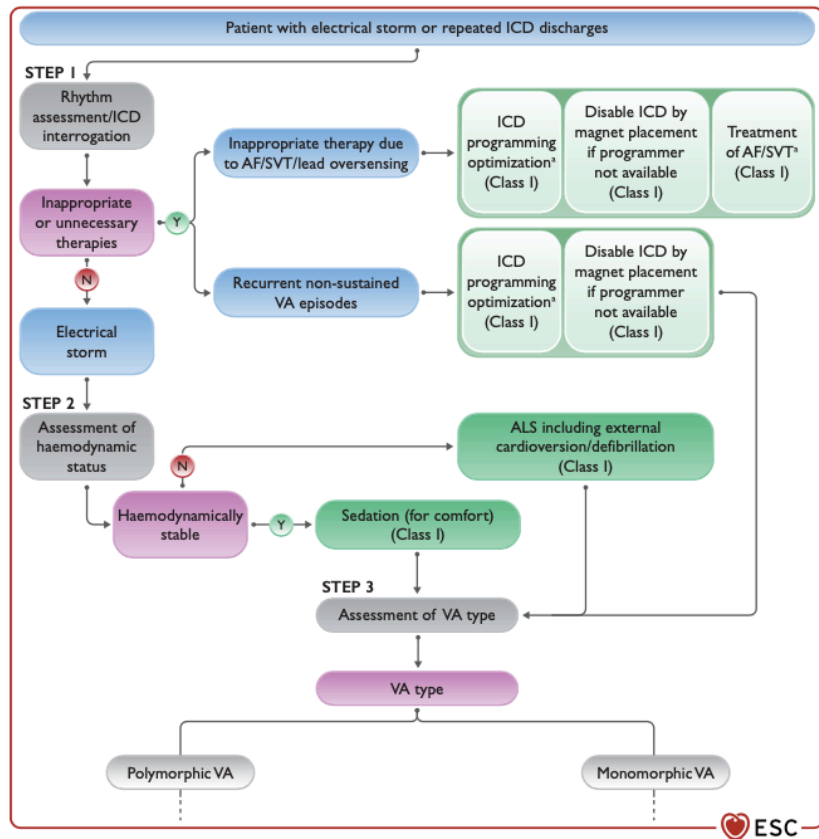
Number at risk:							
LVEF >30%	464	362	255	143	71	48	12
LVEF $\leq 30\%$	491	366	272	161	92	68	24



Number at risk:							
ACE +	795	618	440	257	151	80	30
ACE –	160	126	97	66	38	18	7







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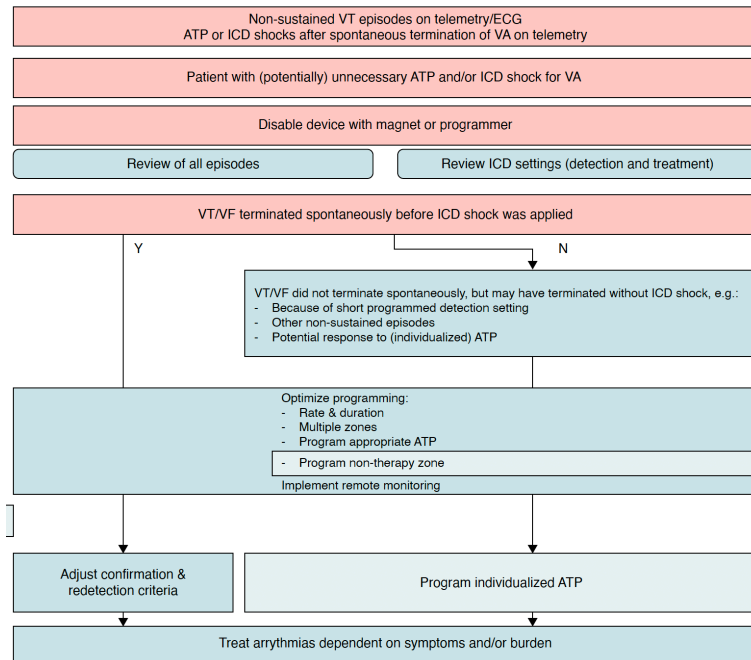
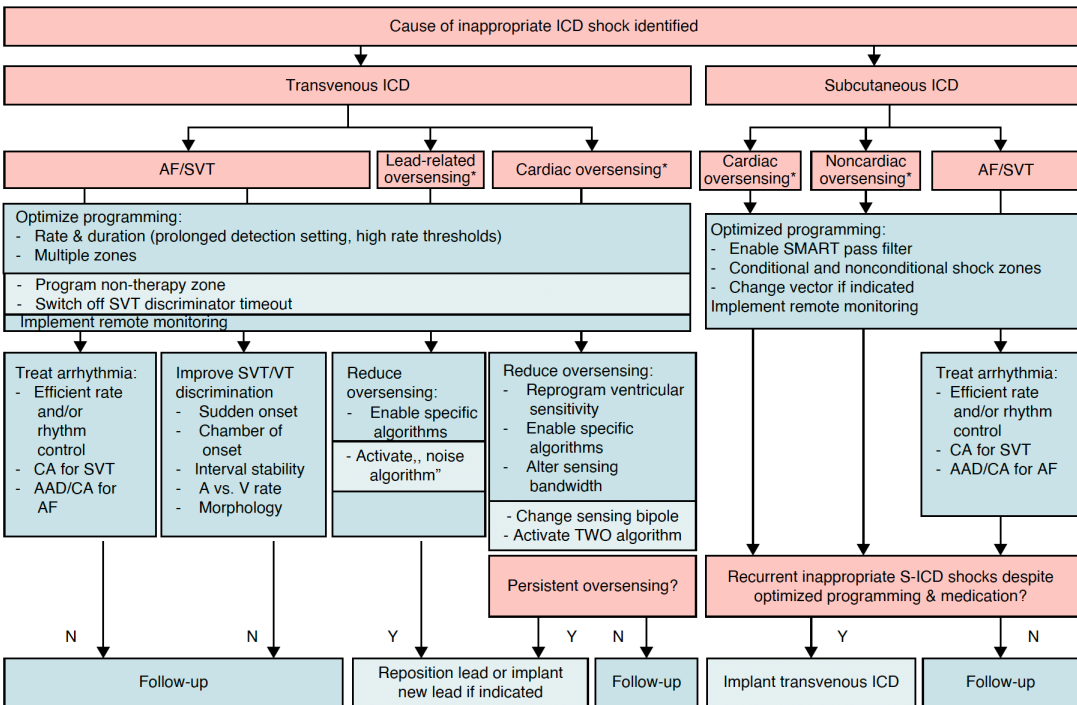
European Heart Journal (2022) 00, 1–130
<https://doi.org/10.1093/eurheartj/ehac262>

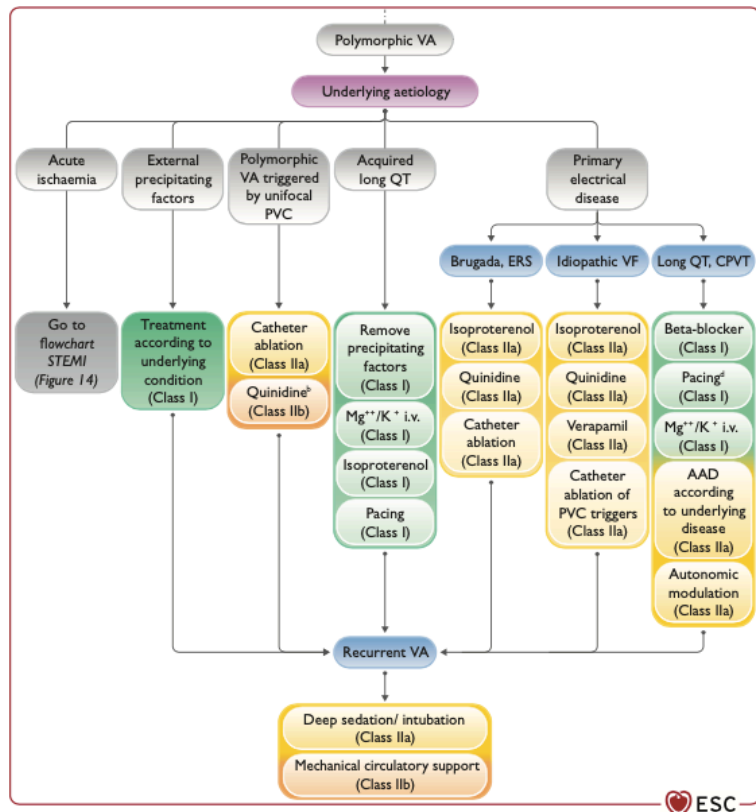
ESC GUIDELINES

2022 ESC Guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death

Management of patients with electrical storm or repeated implantable cardioverter defibrillator discharges.







European Heart Journal (2022) 00, 1–130
European Society of Cardiology <https://doi.org/10.1093/eurheartj/ehac262>

ESC GUIDELINES

2022 ESC Guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death

Polymorphic VA Management based on the Underlying etiology flowchart





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European Heart Journal (2022) **00**, 1–130

<https://doi.org/10.1093/eurheartj/ehac262>

ESC GUIDELINES

2022 ESC Guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death

High VA burden refers to a clinical scenario of very frequent VA episodes requiring ICD shocks, when only short periods of stable rhythm can be achieved. Low VA burden refers to a clinical scenario of repeated ATPs/ICD shocks followed by stable rhythm





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European Heart Journal (2022) 00, 1–130

<https://doi.org/10.1093/eurheartj/ehac262>

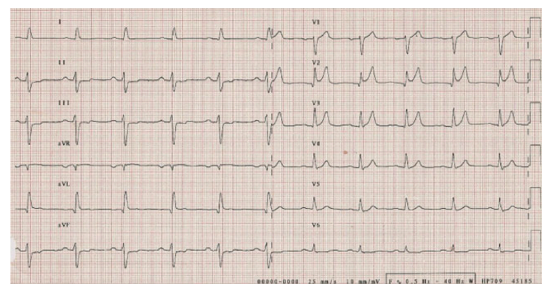
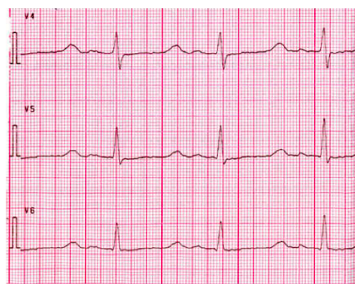
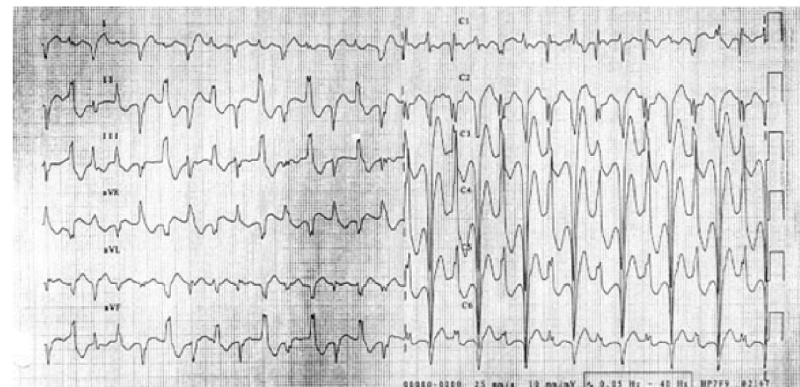
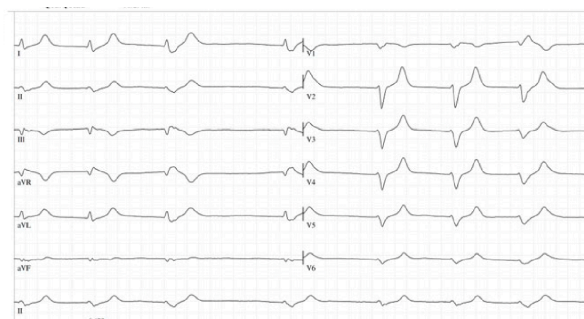
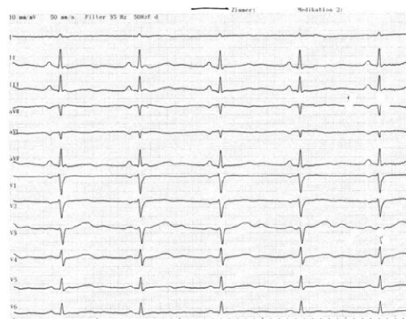
ESC GUIDELINES

2022 ESC Guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death

Management of electrical storm		
Mild to moderate sedation is recommended in patients with electrical storm to alleviate psychological distress and reduce sympathetic tone.	I	C
Antiarrhythmic therapy with beta-blockers (non-selective preferred) in combination with intravenous amiodarone is recommended in patients with SHD and electrical storm unless contraindicated. ^{317,318}	I	B
Intravenous magnesium with supplementation of potassium is recommended in patients with TdP. ²⁹⁵	I	C
Isoproterenol or transvenous pacing to increase heart rate is recommended in patients with acquired LQT syndrome and recurrent TdP despite correction of precipitating conditions and magnesium.	I	C
Catheter ablation is recommended in patients presenting with incessant VT or electrical storm due to SMVT refractory to AADs. ^{330,331}	I	B
Deep sedation/intubation should be considered in patients with an intractable electrical storm refractory to drug treatment. ³²⁵	IIa	C
Catheter ablation should be considered in patients with recurrent episodes of PVT/VF triggered by a similar PVC, non-responsive to medical treatment or coronary revascularization. ^{221,332,333}	IIa	C
Quinidine may be considered in patients with CAD and electrical storm due to recurrent PVT when other AAD therapy fails. ^{323,324}	IIb	C

Autonomic modulation may be considered in patients with electrical storm refractory to drug treatment and in whom catheter ablation is ineffective or not possible. ^{326,328,340}	IIb	C
Institution of mechanical circulatory support may be considered in the management of drug-refractory electrical storm and cardiogenic shock. ³³⁵	IIb	C
Intravenous lidocaine may be considered for the treatment of recurrent PVT/VF not responding to beta-blockers or amiodarone, or if amiodarone is contraindicated during the acute phase of ACS. ⁵⁵⁴	IIb	C

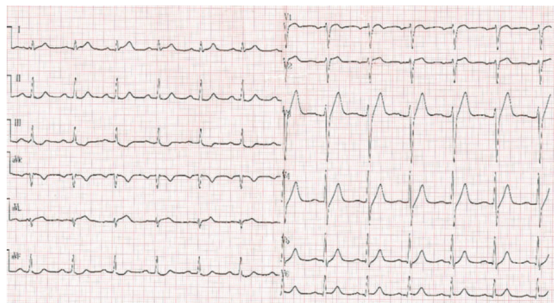




Electrical Storm in Short-QT Syndrome Successfully Treated with Isoproterenol

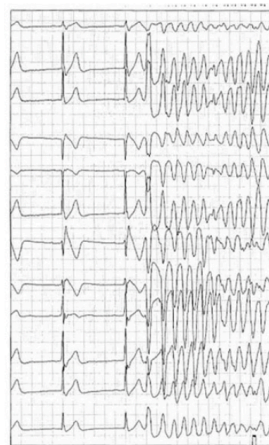
SOK-SITHIKUN BUN, M.D.,* PHILIPPE MAURY, M.D.,† CARLA GIUSTETTO, M.D.,‡ and JEAN-CLAUDE DEHARO, M.D.*

From the *Arrhythmias Unit, Department of Cardiology, La Timone University Hospital, Marseille, France; †Department of Cardiology, Rangueil University Hospital, Toulouse, France; and ‡Division of Cardiology, University of Torino, S. Giovanni Hospital, Torino, Italy



Isoprenaline and quinidine to calm Brugada VF storm

Guy Furniss



Arrhythmia/electrophysiology

Treating arrhythmias with adjunctive magnesium: identifying future research directions

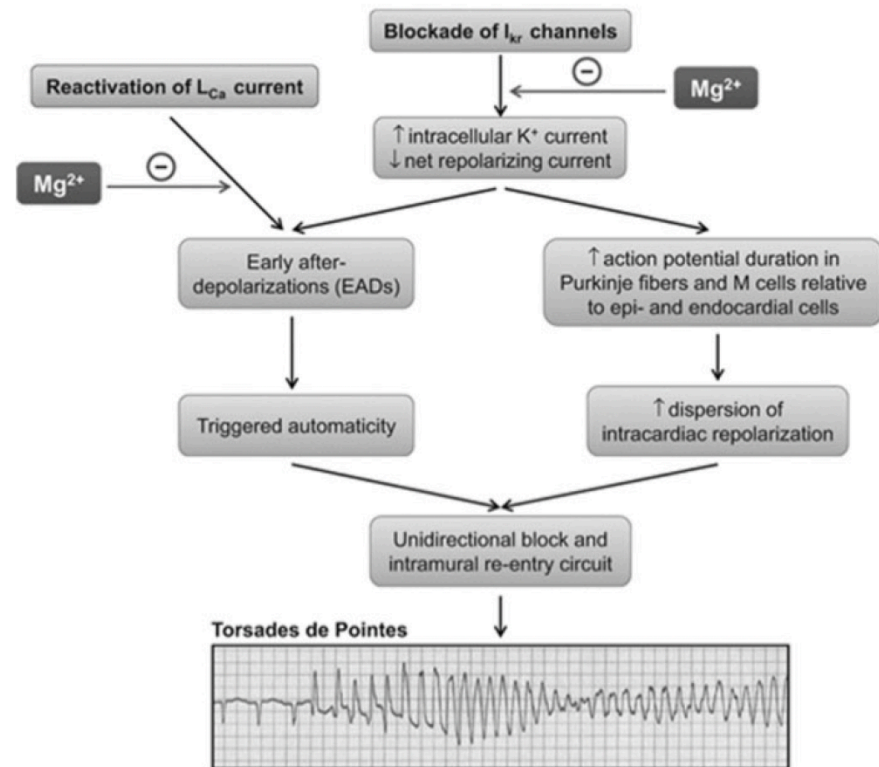
William L. Baker*

Treatment of torsade de pointes with magnesium sulfate

DAN TZIVONI, M.D., SHMUEL BANAI, M.D., CLAUDIO SCHUGER, M.D., JESAIA BENHORIN, M.D., ANDRE KEREN, M.D., SHMUEL GOTTLIEB, M.D., AND SHLOMO STERN, M.D.

Hypomagnesemia in heart failure with ventricular arrhythmias. Beneficial effects of magnesium supplementation

[L. Ceremużyński](#), [J. Gębalska](#), [R. Wołk](#), [E. Makowska](#)

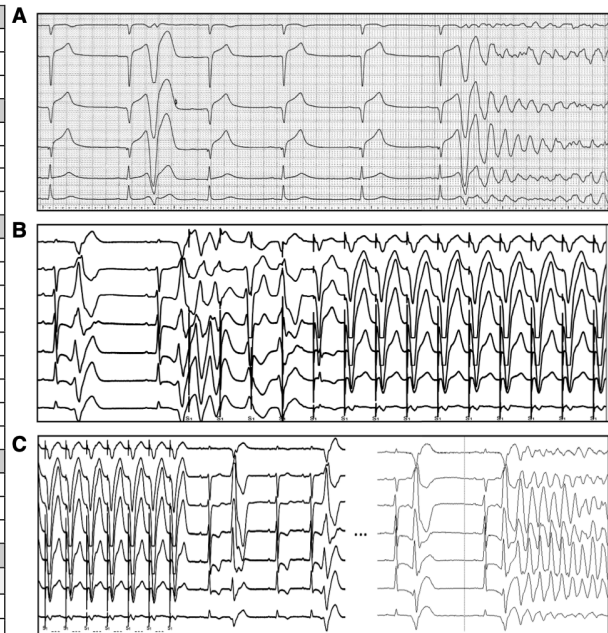


Overdrive pacing for ventricular fibrillation storm after myocardial infarction

Jan Charton ^{1,2,*}, Xavier Bouteiller ^{1,2}, Estelle Gandjbakhch ³,
Xavier Waintraub ³, Cedric Klein⁴, Philippe Maury ⁵, Pierre Baudinaud ⁶,
Eloi Marijon ⁶, Romain Tixier ^{1,2}, Thomas Baudinet ^{1,2}, Frederic Sacher ^{1,2},
Mélèze Hocini ^{1,2}, Michel Haïssaguerre ^{1,2}, and Josselin Duchateau ^{1,2}

Overdrive pacing effectively suppressed recurrent arrhythmias. Neither heart rate nor QTc intervals were related to pacing response.

GENERAL CHARACTERISTICS			
Age – years (±SD)		67 ± 11	
Male sex (%)		39 (83%)	
Post-MI LVEF – % (±SD)		32 ± 11	
BASELINE ECG			
Sinus rhythm		47 (92%)	
Baseline frequency – bpm (±SD)		67 ± 14	
QTc (Bazett) – ms (±SD)		466 ± 37	
PVC coupling – ms (±SD)		346 ± 54	
STORM MANAGEMENT PRIOR TO OVERDRIVE PACING			
β-blockers		29 (57%)	
Amiodarone		42 (82%)	
Lidocaine		39 (77%)	
Magnesium sulfate		28 (55%)	
Quinidine		1 (2%)	
Deep sedation		29 (57%)	
Circulatory support		7 (14%)	
Catheter ablation		5 (10%)	
LCSD		2 (4%)	
OUTCOMES AFTER OP			
Response to OP		47 (92%)	
Death		9 (18%)	
Shocks pre VS after OP		7 [4, 15] vs 0 [0, 1]; p<0.0001	
OVERDRIVE PACING COMPLICATIONS			
Complication	Lead type	Passive temp. lead 27 (53%)	Active fixation 24 (47%)
Hemodynamic failure		2	2
Lead-related complication		8	2



Beta-blocker therapy for long QT syndrome and catecholaminergic polymorphic ventricular tachycardia: Are all beta-blockers equivalent?

Michael J. Ackerman, MD, PhD,^{*} Silvia G. Priori, MD, PhD,[†] Anne M. Dubin, MD, FHRS,[‡]
Peter Kowey, MD,[§] Nicholas J. Linker, MD, FHRS,[¶] David Slotwiner, MD, FHRS,[#]
John Triedman, MD, FHRS, CCDS, CEPS,^{**} George F. Van Hare, MD, FHRS, CCDS, CEPS,^{††}
Michael R. Gold, MD, PhD, FHRS (Chair)^{‡‡}

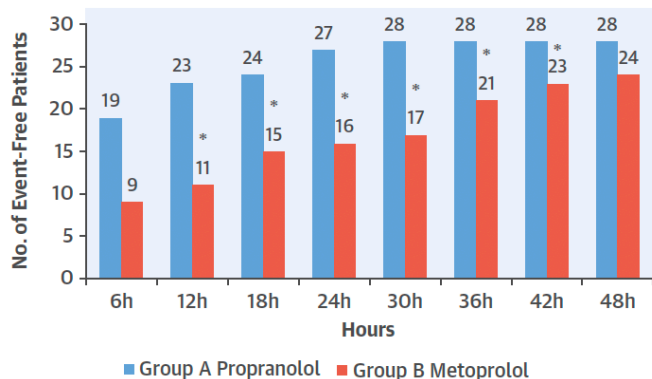
There is substantial consensus among experts that nadolol is the preferred effective drug therapy in LQTS. Whereas the preference for nadolol as first-choice agent is established among experts, no conclusive recommendation can be provided to identify the next best option.



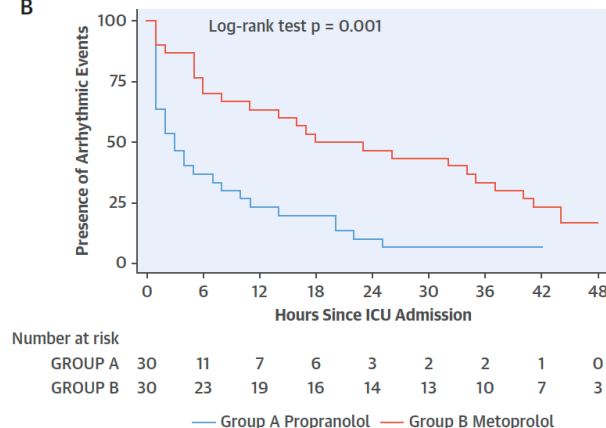
Propranolol Versus Metoprolol for Treatment of Electrical Storm in Patients With Implantable Cardioverter-Defibrillator

Sofia Chatzidou, MD, PhD,^{a,*} Christos Kontogiannis, MD,^{a,*} Diamantis I. Tsilimigras, MD,^{b,*} Georgios Georgiopoulos, MD, PhD,^a Marinos Kosmopoulos, MD,^b Elektra Papadopoulou, MD,^a Georgios Vasilopoulos, MD, PhD,^a Stylianos Rokas, MD, PhD^a

A



B



Efficacy and Safety of Landiolol in Patients With Ventricular Tachyarrhythmias With or Without Renal Impairment — Subanalysis of the J-Land II Study —

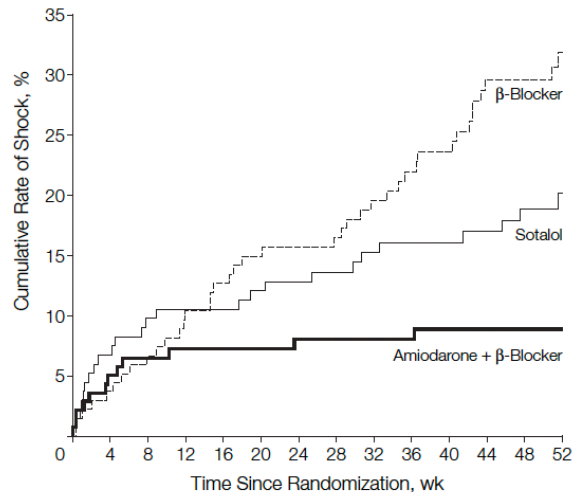
Tsuyoshi Shiga, MD, PhD; Takanori Ikeda, MD, PhD; Wataru Shimizu, MD, PhD; Koichiro Kinugawa, MD, PhD; Atsuhiko Sakamoto, MD, PhD; Ryoza Nagai, MD, PhD; Takashi Daimon, PhD; Kaori Oki; Haruka Okamoto; Takeshi Yamashita, MD, PhD



Comparison of β -Blockers, Amiodarone Plus β -Blockers, or Sotalol for Prevention of Shocks From Implantable Cardioverter Defibrillators

The OPTIC Study: A Randomized Trial

Amiodarone plus β -blocker is effective for preventing these shocks and is more effective than sotalol but has an increased risk of drug-related adverse effects.



No. at Risk					
β -Blocker	138	119	109	91	42
Sotalol	134	118	108	94	35
Amiodarone + β -Blocker	140	124	115	106	56



Circulation

Volume 92, Issue 11, 1 December 1995; Pages 3264-3272

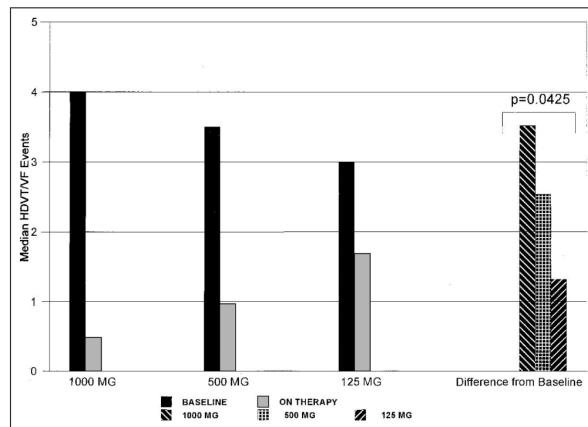
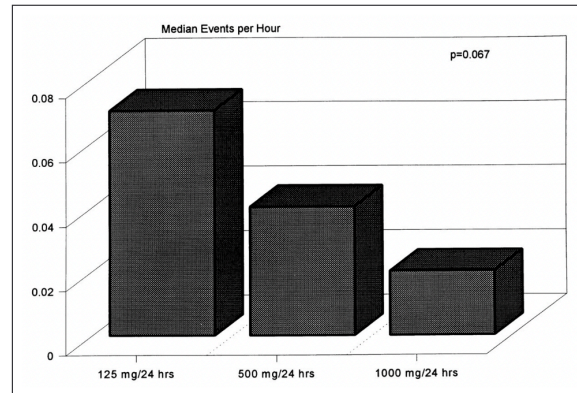
<https://doi.org/10.1161/01.CIR.92.11.3264>



ARTICLE

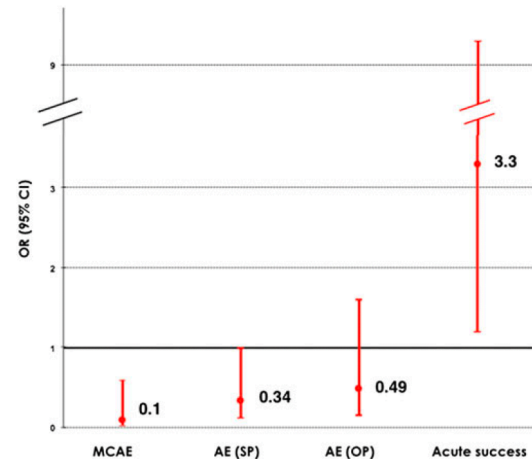
Dose-Ranging Study of Intravenous Amiodarone in Patients With Life-Threatening Ventricular Tachyarrhythmias

Melvin M. Scheinman, Joseph H. Levine, David S. Cannom, Ted Friehling, Harry A. Kopelman, Donald A. Chilson, Edward V. Platia, David J. Wilber, Peter R. Kowey, and ¹for the Intravenous Amiodarone Multicenter InvestigatorsGroup



Randomized comparison of intravenous procainamide vs. intravenous amiodarone for the acute treatment of tolerated wide QRS tachycardia: the PROCAMIO study

Mercedes Ortiz^{1†}, Alfonso Martín², Fernando Arribas³, Blanca Coll-Vinent⁴, Carmen del Arco⁵, Rafael Peinado⁶ and Jesús Almendral^{1*†}, on Behalf of the PROCAMIO Study Investigators

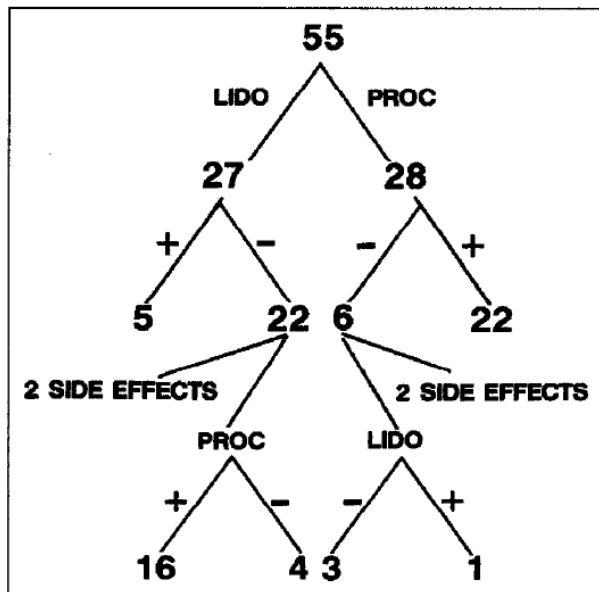


	n	MCAE in procainamide group (%)	MCAE in amiodarone group (%)	OR (95% CI)	P
Including all patients	74	(6/39) 15.4%	(15/35) 42.8%	0.24 (0.08–0.73)	0.011
Including only patients who were analysed	62	(3/33) 9.1%	(12/29) 41.4%	0.14 (0.03–0.57)	0.006
Including only patients with structural heart disease	49	(3/26) 11.5%	(10/23) 43.5%	0.17 (0.04–0.73)	0.017
OR adjusted for age and sex	62	(3/33) 9.1%	(12/29) 41.4%	0.10 (0.02–0.48)	0.004
OR adjusted ^a	62	(3/33) 9.1%	(12/29) 41.4%	0.11 (0.02–0.55)	0.008



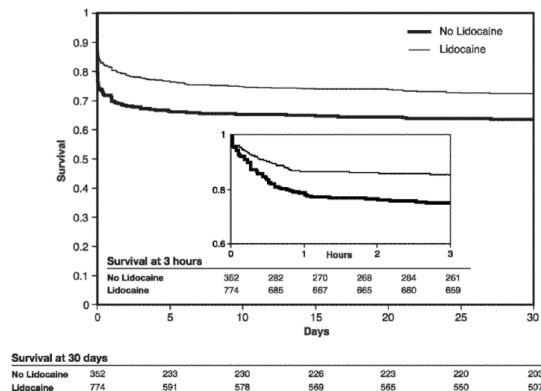
Comparison of Procainamide and Lidocaine in Terminating Sustained Monomorphic Ventricular Tachycardia

Anton P.M. Gorgels, MD, PhD, Adri van den Dool, Anton Hofs, Rob Mulleneers, Joep L.R.M. Smeets, MD, PhD, Marc A. Vos, PhD, and Hein J.J. Wellens, MD, PhD



Antiarrhythmic Drug Therapy for Sustained Ventricular Arrhythmias Complicating Acute Myocardial Infarction

Jonathan P. Piccini, MD, MHS*, Phillip J. Schulte*, Karen S. Pieper, MS*, Rajendra H. Mehta, MD, MS*, Harvey D. White, DSc†, Frans Van de Werf, MD, PhD‡, Diego Ardissino, MD§, Robert M. Califf, MD||, Christopher B. Granger, MD*, E. Magnus Ohman, MD*, and John H. Alexander, MD, MHS*

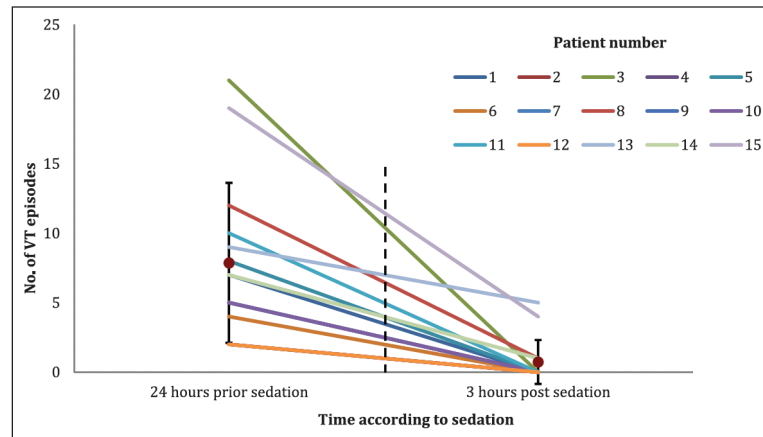
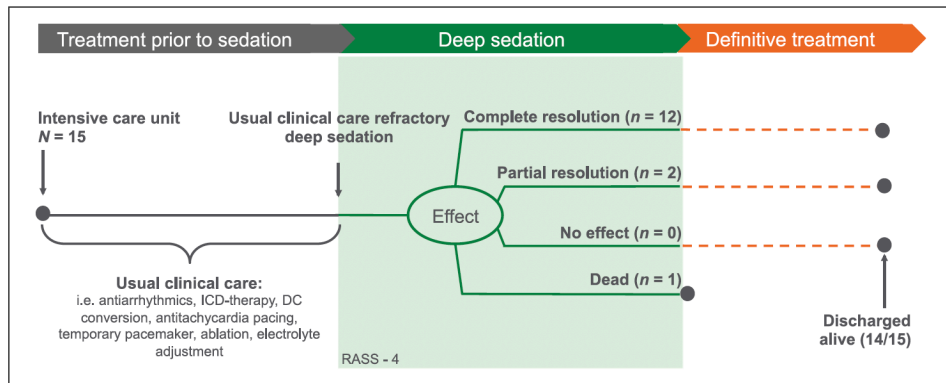


Deep sedation as temporary bridge to definitive treatment of ventricular arrhythmia storm

Johan S Bundgaard, Peter K Jacobsen, Johannes Grand, Matias G Lindholm, Christian Hassager, Steen Pehrson, Jesper Kjaergaard and Henning Bundgaard

European Heart Journal
Acute Cardiovascular Care
ESC
European Society of Cardiology

European Heart Journal: Acute Cardiovascular Care
2020, Vol. 9(6) 657-664
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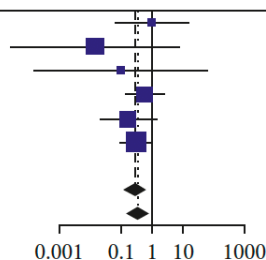
Deep sedation was effective and safe for the temporary management of malignant VT/VF refractory to usual treatment. In emergencies, deep sedation may be widely accessible at both secondary and tertiary centers and a clinically useful bridge to definitive treatment of VT



Review Article

Dexmedetomidine Reduces Incidences of Ventricular Arrhythmias in Adult Patients: A Meta-Analysis

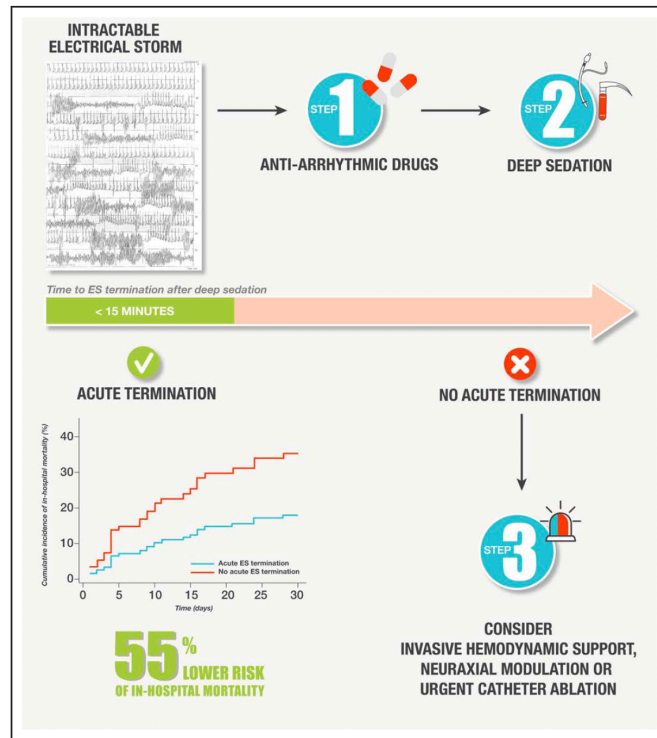
Study	Experimental Events	Experimental Total	Control Events	Control Total	Weight (fixed %)	Weight (random %)	Risk Ratio MH, Fixed + Random, 95% CI	Risk Ratio MH, Fixed + Random, 95% CI
Jalonen et al. 1997	1	40	1	40	3.3	8.4	1.00 [0.06; 15.44]	
Herr et al. 2003	0	148	7	147	23.5	1.6	0.01 [0.00; 7.16]	
Corbett et al. 2005	0	43	1	46	3.5	1.5	0.10 [0.00; 62.15]	
Shehabi et al. 2009	3	152	5	147	16.8	31.4	0.58 [0.14; 2.38]	
Ren et al. 2013	1	81	6	81	19.8	14.3	0.17 [0.02; 1.35]	
Soltani et al. 2017	3	38	10	38	33.0	42.9	0.30 [0.09; 1.01]	
<i>Total (fixed effect, 95% CI)</i>		502		499	100.0	--	0.27 [0.13; 0.57]	
<i>Total (random effects, 95% CI)</i>					--	100	0.35 [0.16; 0.76]	
Heterogeneity: $\tau^2 = 0$; $\chi^2 = 2.78$, $df = 5$ ($P = 0.73$); $I^2 = 0\%$								





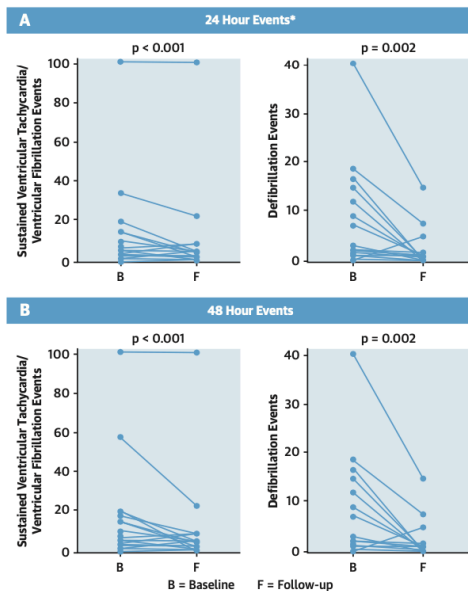
RESEARCH LETTER

Effectiveness of Deep Sedation for Patients With Intractable Electrical Storm Refractory to Antiarrhythmic Drugs



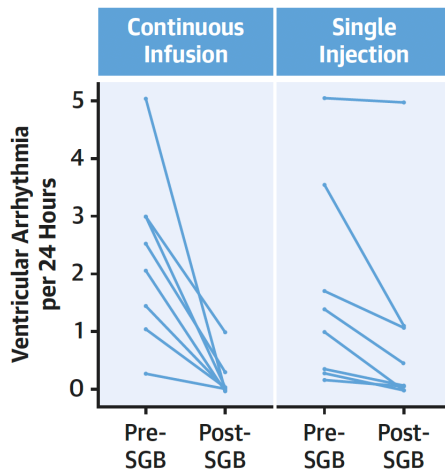
Stellate Ganglion Blockade for the Treatment of Refractory Ventricular Arrhythmias

Marat Fudim, MD, MHS,^{a,b} Yawar J. Qadri, MD, PhD,^c Nathan H. Waldron, MD, MHS,^c
Richard L. Boortz-Marx, MD, MS,^c Arun Ganesh, MD,^c Chetan B. Patel, MD,^a Mihai V. Podgoreanu, MD,^c
Albert Y. Sun, MD,^a Carmelo A. Milano, MD,^d Betty C. Tong, MD, MHS,^d David H. Harpole, Jr, MD,^e
Joseph P. Mathew, MD, MHS, MBA,^c Jonathan P. Piccini, MD, MHS^{a,b}



Stellate Ganglion Blockade With Continuous Infusion Versus Single Injection for Treatment of Ventricular Arrhythmia Storm

Saket Sanghai, MBBS,^a Nicholas J. Abbott, MD,^a Thomas A. Dewland, MD,^a Charles A. Henrikson, MD,^a
Miriam R. Elman, MPH, MS,^b Michael Wollenberg, MD,^c Ryan Ivie, MD,^c Julio Gonzalez-Sotomayor, MD,^c
Babak Nazer, MD^a



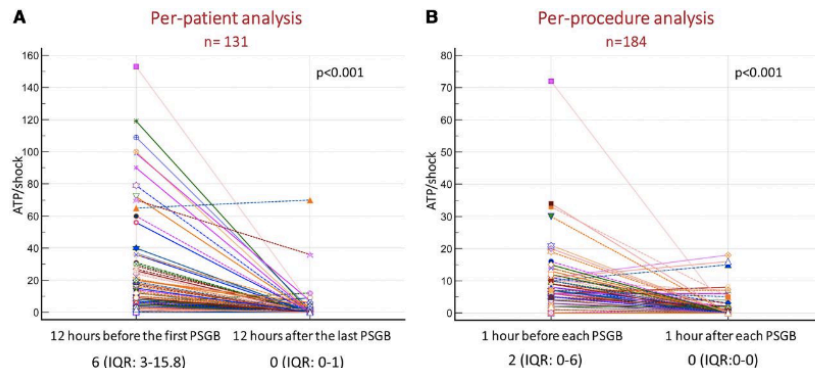
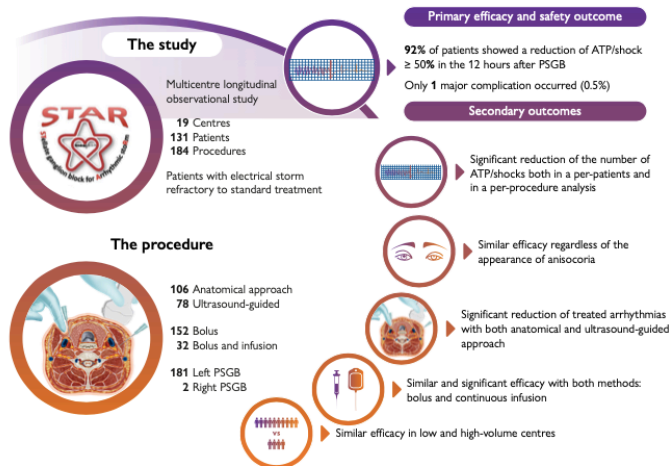
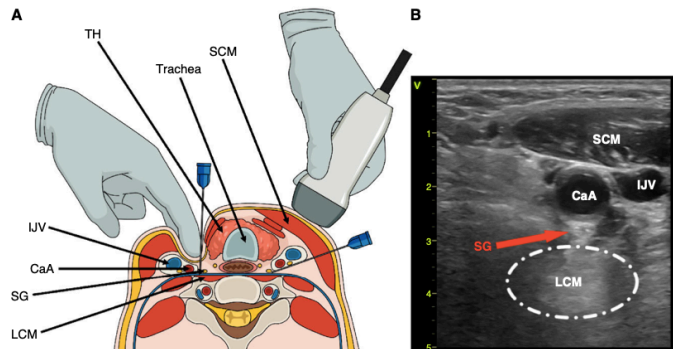
Single injection:
54% reduction in
VA burden

**Continuous
Infusion: 94%**
reduction in VA
burden



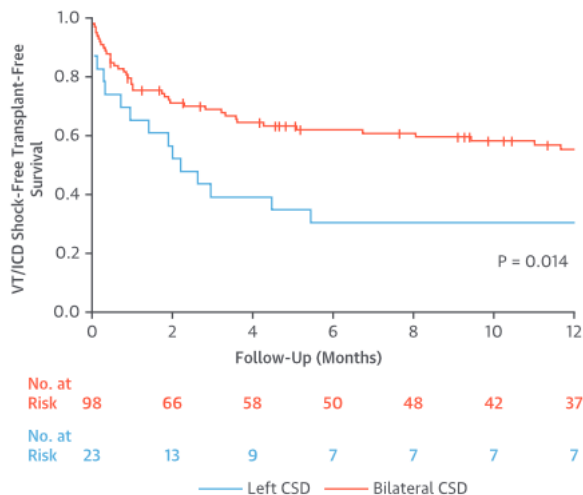
Electrical storm treatment by percutaneous stellate ganglion block: the STAR study

Simone Savastano ^{1*}, Enrico Baldi ¹, Sara Compagnoni ^{1,2}, Roberto Rordorf ¹, Antonio Sanzo ¹, Francesca Romana Gentile ^{1,2}, Veronica Dusi ^{3,4}, Simone Frea ^{3,4}, Carol Gravinese ^{3,4}, Filippo Maria Cauti ⁵, Gianmarco Iannopolo ⁶, Francesco De Sensi ⁷, Edoardo Gandolfi ⁸, Laura Frigerio ^{8,9}, Pasquale Crea ¹⁰, Domenico Zagari ¹¹, Matteo Casula ¹², Giuseppe Sangiorgi ¹³, Simone Persampieri ¹⁴, Gabriele Dell'Era ¹⁵, Giuseppe Patti ^{15,16}, Claudia Colombo ¹⁷, Giacomo Mugnai ¹⁸, Francesco Notaristefano ¹⁹, Alberto Barengo ¹⁹, Roberta Falcetti ²⁰, Giovanni Battista Perego ²¹, Giuseppe D'Angelo ²², Nikita Tanese ²², Alessia Currao ¹, Vito Sgromo ²³, and Gaetano Maria De Ferrari ^{3,4}; the STAR study group



Cardiac Sympathetic Denervation for Refractory Ventricular Arrhythmias

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6-Month Outcomes in Patients With Implantable Cardioverter-Defibrillators Undergoing Renal Sympathetic Denervation for the Treatment of Refractory Ventricular Arrhythmias

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Thoracic Epidural Anesthesia Can Be Effective for the Short-Term Management of Ventricular Tachycardia Storm

Duc H. Do, MD; Jason Bradfield, MD; Olujimi A. Ajijola, MD, PhD; Marmar Vaseghi, MD, PhD; John Le, MD; Siamak Rahman, MD; Aman Mahajan, MD, PhD; Akihiko Nogami, MD, PhD; Noel G. Boyle, MD, PhD; Kalyanam Shivkumar, MD, PhD

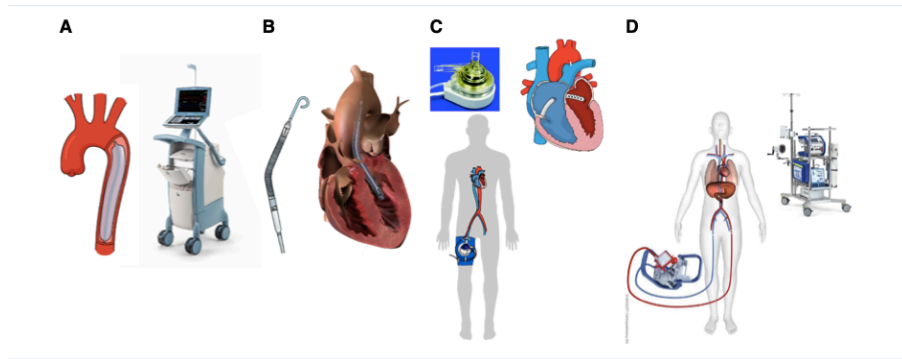


TABLE 3 MCS Devices and Their Role in Catheter Ablation for Electrical Storm⁴⁶

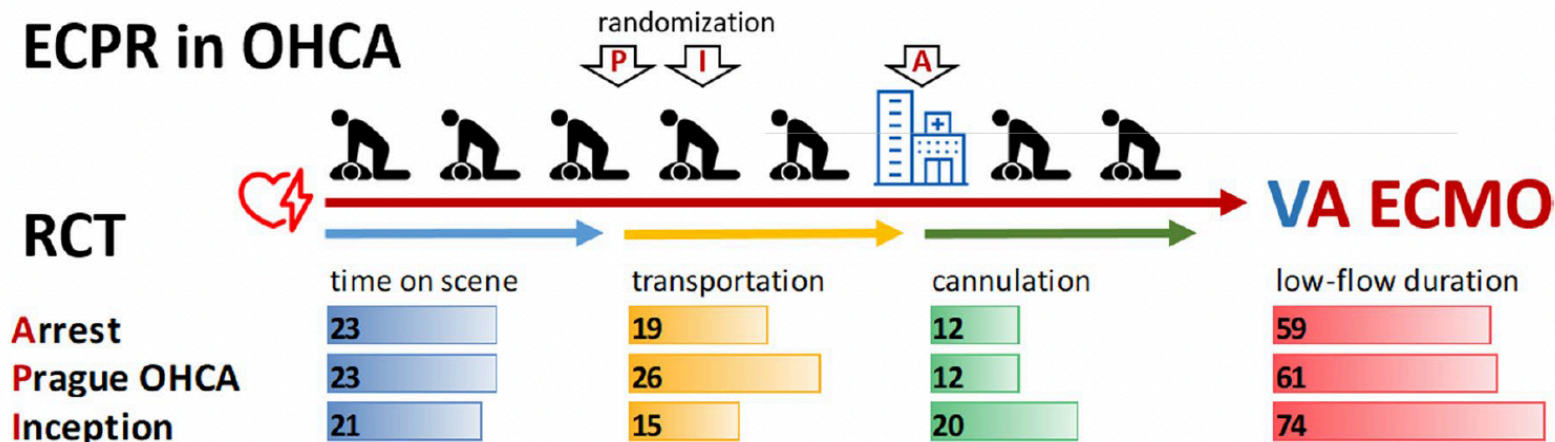
Modality	Function	Advantages	Disadvantages
IABP	Inflation in diastole increases coronary perfusion; deflation during systole reduces afterload	Easy to place and widely available Lower risk of complications Unloads LV by reducing afterload	Primarily effective in sinus rhythm Ineffective at higher heart rates or during VA Contraindicated in patients with AI (as with all other devices) Modest hemodynamic support
Impella	A continuous-flow pump placed across the AV provides LV unloading and augments cardiac output	Relatively easy to place and widely available Significant increase in cardiac output Some support during VA Directly unloads LV	Contraindicated in mechanical AV (must cross aortic valve) Crowded LVOT limits retro-aortic approach to ablation Can cause ventricular ectopy More complications than IABP
TandemHeart	Arterial bypass system with transseptal LA access and external pump	Full cardiac output support Addition of oxygenation circuit is possible Some support during VA	Not widely available Requires transseptal access (leaving a residual ASD) Large arterial and venous sheaths with risk of vascular complications
Venoarterial ECMO	Portable complete cardiopulmonary bypass	Full biventricular cardiac and pulmonary support Support during VA or cardiac arrest Can be placed at bedside without fluoroscopy	Large arterial and venous sheaths with risk of vascular complications Thromboembolic and bleeding risks Standard configurations increase LV afterload

MCS may be appropriate:

- In patients with acute ES for optimizing haemodynamics
- In patients undergoing ablation of non-tolerated VAs to support mapping and ablation.
- Prophylactically before CA in high-risk patients, presenting with an ES or clustered VA



ECPR in OHCA



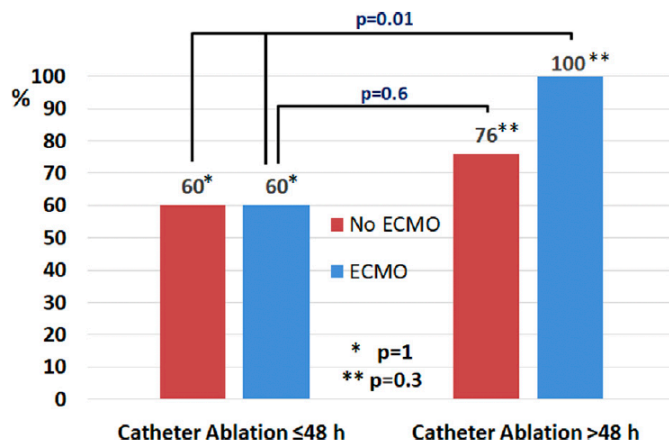
Three RCTs examined the role of extracorporeal cardiopulmonary resuscitation (ECPR) in patients following out-of-hospital cardiac arrest (OHCA). Time plays a crucial role in ECPR, as prognosis strongly correlates negatively with low-flow duration.



Timing of Ablation and Prognosis of Patients With Electrical Storm and Scar-Related Left Ventricular Dysfunction



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Javier Fernández-Portales, MD, PhD^b, Manuel Durán, MD^c, Olga Durán, MD^d, Jendri Pérez, MD^a,
Juliana Elices, MD^d, José Luis Morónigo, MD, PhD^a, Francisco Martín, MD, PhD^a,
Carlos González-Juanatey, MD PhD^d, and Pedro L. Sánchez, MD, PhD^a



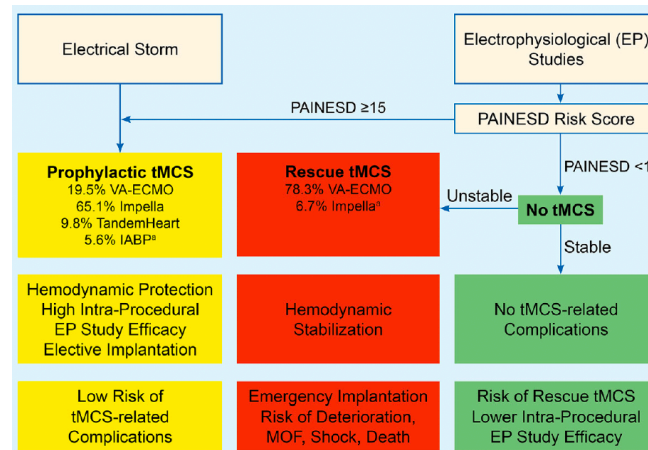
Painesd Score		Points
P	Pulmonary disease	5
A	Age >60 years	3
I	Ischemic cardiomyopathy	6
N	NYHA functional class III-IV	6
E	Ejection fraction <25%	3
S	VT Storm	5
D	Diabetes	3
Risk of hemodynamic decompensation during VT ablation		
≤8 points		Low risk
9-15 points		Intermediate risk
≥15-17 points		High risk

Catheter Ablation for Electrical Storm: Perioperative Checklist		
Categorize		
	☐ Primary arrhythmia	MMVT: EPS to identify scar, circuits, or areas of automaticity. PMVT/VF: EPS to identify triggers.
	☐ Structural substrate	Consider echo, CT and/or CMR to identify cardiomyopathy type and characterize areas of abnormal myocardium.
Optimize		
	☐ Clinical stability	Optimize volume status, renal function, and electrolytes.
	☐ Triggers	Identify and stabilize acute triggers: adrenergic stimuli, electrolyte abnormalities, ischemia, etc.
Procedural Planning		
	☐ Safety considerations	Hemodynamic stability achieved? Choice and timing of procedural anticoagulation. Left ventricular thrombus ruled out?
	☐ Anesthesia plan	Partner with anesthesia team to optimize plan based on anticipated procedure length, inducibility of arrhythmia, etc.
	☐ Hemodynamic support	Use PAINESD score for risk stratification. Consider benefits of each MCS modality.
	☐ LV access plan	Mechanical aortic or mitral valve? Anticipated need for epicardial access? Prior cardiac surgery or pericarditis?



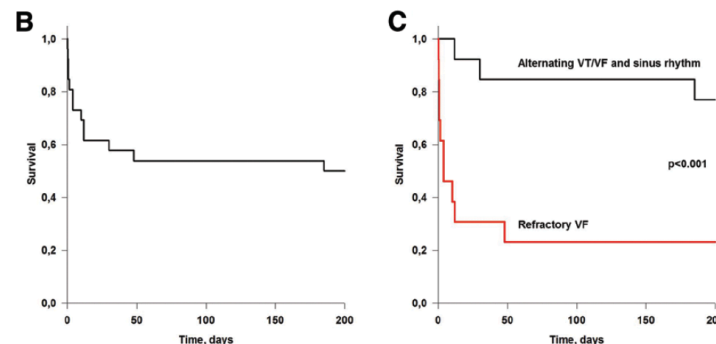
Mechanical circulatory support for life-threatening arrhythmia: A systematic review

Silvia Mariani^{a,*1}, L. Christian Napp^{b,1}, Valeria Lo Coco^{c,1}, Thijs S.R. Delnoij^{d,e,1}, Justin G.L.M. Luermans^{d,1}, Rachel M.A. ter Bekke^{d,1}, Carl Timmermans^{d,1}, Tong Li^{a,1}, Guenes Dogan^{a,1}, Jan D. Schmitto^{a,1}, Jos Maessen^{c,f,1}, Bart Maesen^{c,1}, Roberto Lorusso^{c,f,1}



Effectiveness of Extracorporeal Life Support for Patients With Cardiogenic Shock Due To Intractable Arrhythmic Storm

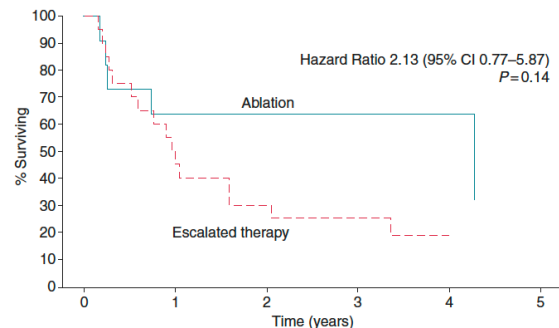
Solène Le Pennec-Prigent, MD^{1,2,3,4}; Erwan Flecher, MD, PhD^{4,5}; Vincent Auffret, MD^{1,2,3,4}; Guillaume Leurent, MD^{1,2,3,4}; Jean-Claude Daubert, MD, PhD^{1,2,3,4}; Christophe Leclercq, MD, PhD^{1,2,3,4}; Philippe Mabo, MD^{1,2,3,4}; Jean-Philippe Verhoye, MD, PhD^{4,5}; Raphael P. Martins, MD, PhD^{1,2,3,4}



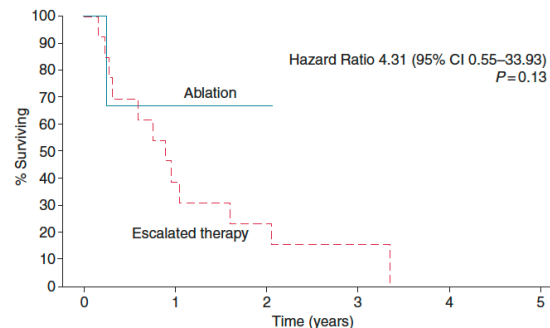
Ventricular tachycardia characteristics and outcomes with catheter ablation vs. antiarrhythmic therapy: insights from the VANISH trial

Marc W. Deyell^{1*}, Steve Doucette², Ratika Parkash², Isabelle Nault³, Lorne Gula⁴, Christopher Gray², Martin Gardner², Laurence D. Sterns⁵, Jeff S. Healey⁶, Vidal Essebag⁷, and John L. Sapp²

B Presentation with electrical storm



# at Risk	0	1	2	3	4	5
Ablation	12	7	5	3	3	1
Escalated	20	10	6	5	1	1



# at Risk	0	1	2	3	4	5
Ablation	3	2	2	1	1	1
Escalated	13	5	3	2	0	

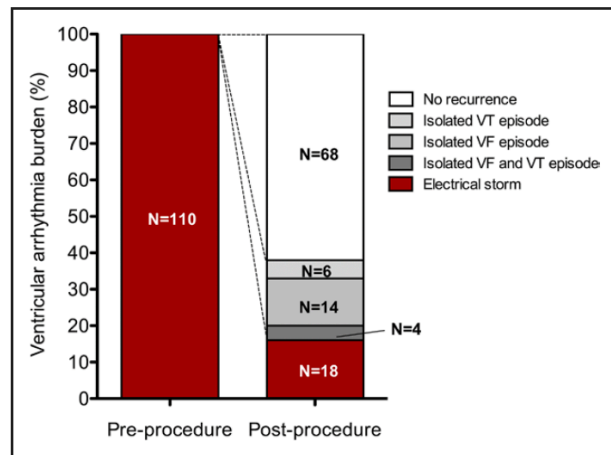
Patients presenting with electrical storm demonstrated similar outcomes to the overall trial population, with a trend to benefit of catheter ablation, particularly in those on amiodarone.



ORIGINAL RESEARCH ARTICLE

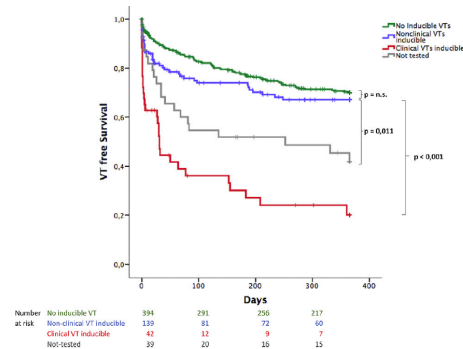
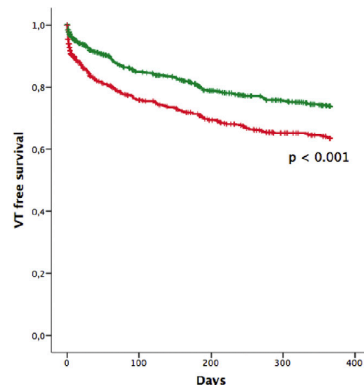
Catheter Ablation of Refractory Ventricular Fibrillation Storm After Myocardial Infarction

A Multicenter Study



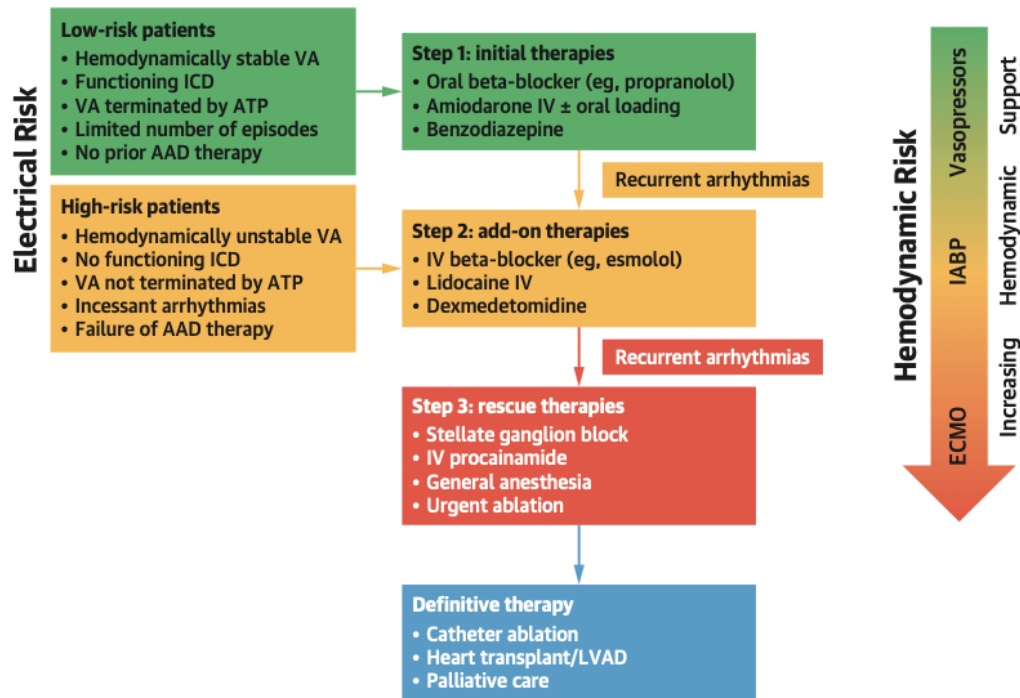
Successful ventricular tachycardia ablation in patients with electrical storm reduces recurrences and improves survival

Pasquale Vergara, MD, PhD,^{*} Roderick Tung, MD,[†] Marmar Vaseghi, MD, PhD, FHRS,[‡] Chiara Brombin, PhD,[§] David Frankel, MD,^{||} Luigi Di Biase, MD, PhD,[¶] Koichi Nagashima, MD,[#] Usha Tedrow, MD, MS,[#] Wendy S. Tzou, MD,^{**} William H. Sauer, MD,^{*} Nilesh Mathuria, MD,^{††} Shiro Nakahara, MD, PhD,^{‡‡} Kairav Vakil, MD,^{§§} Venkat Tholakanahalli, MD,^{§§} T. Jared Bunch, MD,^{||||} J. Peter Weiss, MD,^{||||} Timm Dickfeld, MD,^{¶¶} Rama Vunnam, MD,^{¶¶} Dhanunjaya Lakireddy, MD,^{##} J. David Burkhardt, MD,^{***} Anna Correra, MD,^{*} Pasquale Santangeli, MD,^{||} David Callans, MD,^{||} Andrea Natale, MD,^{***} Francis Marchlinski, MD,^{||} William G. Stevenson, MD,[#] Kalyanam Shivkumar, MD, PhD,[‡] Paolo Della Bella, MD^{*}



Intensity	Antiarrhythmic Drugs	Adrenergic Blockade	Sedation/Anxiolysis	Hemodynamic Support
Step 1	Amiodarone IV* • Bolus 300 mg (max 5 mg/kg) over 20 min • Repeat 150 mg bolus over 10 min for recurrent VA • Infusion 1 mg/min until free from VA ≥ 6 hours (may continue for longer) • Continue 0.5 mg/min until ES resolves	Oral beta-blocker • Propranolol 20-40 mg Q6h (preferred) • Metoprolol tartrate 25-50 mg Q6h (may be less effective) • May instead increase GDMT beta-blocker (eg, bisoprolol, carvedilol, metoprolol succinate) for selected low-risk patients	Benzodiazepine • Lorazepam 1 mg Q4-6h PRN • Diazepam 5 mg Q4-6h PRN • Midazolam 2 mg Q1-2h PRN	Vasopressors • Phenylephrine 0.1-2.0 $\mu\text{g/kg/min}$ • Vasopressin 0.01-0.04 U/min • Norepinephrine 0.02-0.2 $\mu\text{g/kg/min}$
Step 2	Lidocaine IV† • Bolus 1-1.5 mg/kg (max 100-120 mg) • May repeat 0.5-0.75 mg/kg Q5-10 min x1-2 doses (max 300 mg or 3 mg/kg) • Infusion 1-2 mg/min (max 4 mg/min) • Goal serum procainamide concentration: • 1.5-5 $\mu\text{g/mL}$	IV beta-blocker • Esmolol • Bolus 0.5 mg/kg (may repeat Q5 min x2) • Infusion 50-300 $\mu\text{g/kg/min}$ • Propranolol 1-3 mg Q5 min (max 5 mg) • Metoprolol 2.5-5 mg Q5 min (max 15 mg)	Dexmedetomidine • Bolus (optional) 0.5-1 $\mu\text{g/kg}$ over 10 min (typically not recommended due to risk of hypotension) • Infusion 0.2-0.7 $\mu\text{g/kg/h}$ (maximum 1.0-1.5 $\mu\text{g/kg/h}$)	Intra-aortic balloon pump • Contraindicated with aortic aneurysm/dissection, severe aortic insufficiency, or peripheral vascular disease • Less effective with tachycardia or atrial fibrillation
Step 3	Procainamide IV‡ • Bolus 10-15 mg/kg (max 17-20 mg/kg, usually 1 g total) over 30-60 min • Infusion 1-2 mg/min (max 4 mg/min) • Goal serum procainamide concentration: • 4-8 $\mu\text{g/mL}$ (up to 10 $\mu\text{g/mL}$)	Stellate ganglion blockade • Left stellate ganglion blockade • 20 mL of 0.25% bupivacaine without epinephrine • Bilateral blocks if intubated	General anesthesia • Endotracheal intubation • Propofol infusion often used, titrated to RAAS goal of ~ 3 • Opioid typically added (eg, fentanyl infusion)	Advanced MCS • ECMO preferred • Percutaneous LVAD can be considered for selected patients • Contraindicated with severe aortic insufficiency or peripheral vascular disease





Conclusions

- **Electrical storm is a life-threatening clinical emergency** associated with high morbidity and mortality, requiring prompt recognition and immediate intervention.
- **Early identification of reversible triggers** and rapid escalation to advanced therapies are essential to improve arrhythmia control and patient outcomes.
- **A stepwise, escalating therapeutic approach** allows timely optimization of antiarrhythmic drugs, device reprogramming, sedation, catheter ablation, and advanced mechanical circulatory support when indicated.
- **Management of electrical storm requires a multidisciplinary team**, involving electrophysiologists, heart failure specialists, intensivists, interventional cardiologists, cardiac surgeons, anesthesiologists to ensure comprehensive and individualized care.
- **Invasive strategies**, including stellate ganglion neuromodulation, temporary mechanical circulatory support (tMCS), and catheter ablation in appropriately selected patients, appear to be effective in reducing the arrhythmic burden and may represent valuable therapeutic options for the management of electrical storm.

