In-hospital and out-of-hospital CPR

Davide Zanuttini
Ilaria Armellini

AZIENDA OSPEDALIERO-UNIVERSITARIA di UDINE
S. MARIA DELLA MISERICORDIA
DIPARTIMENTO di SCIENZE CARDIOPOLMONARI

OHCA

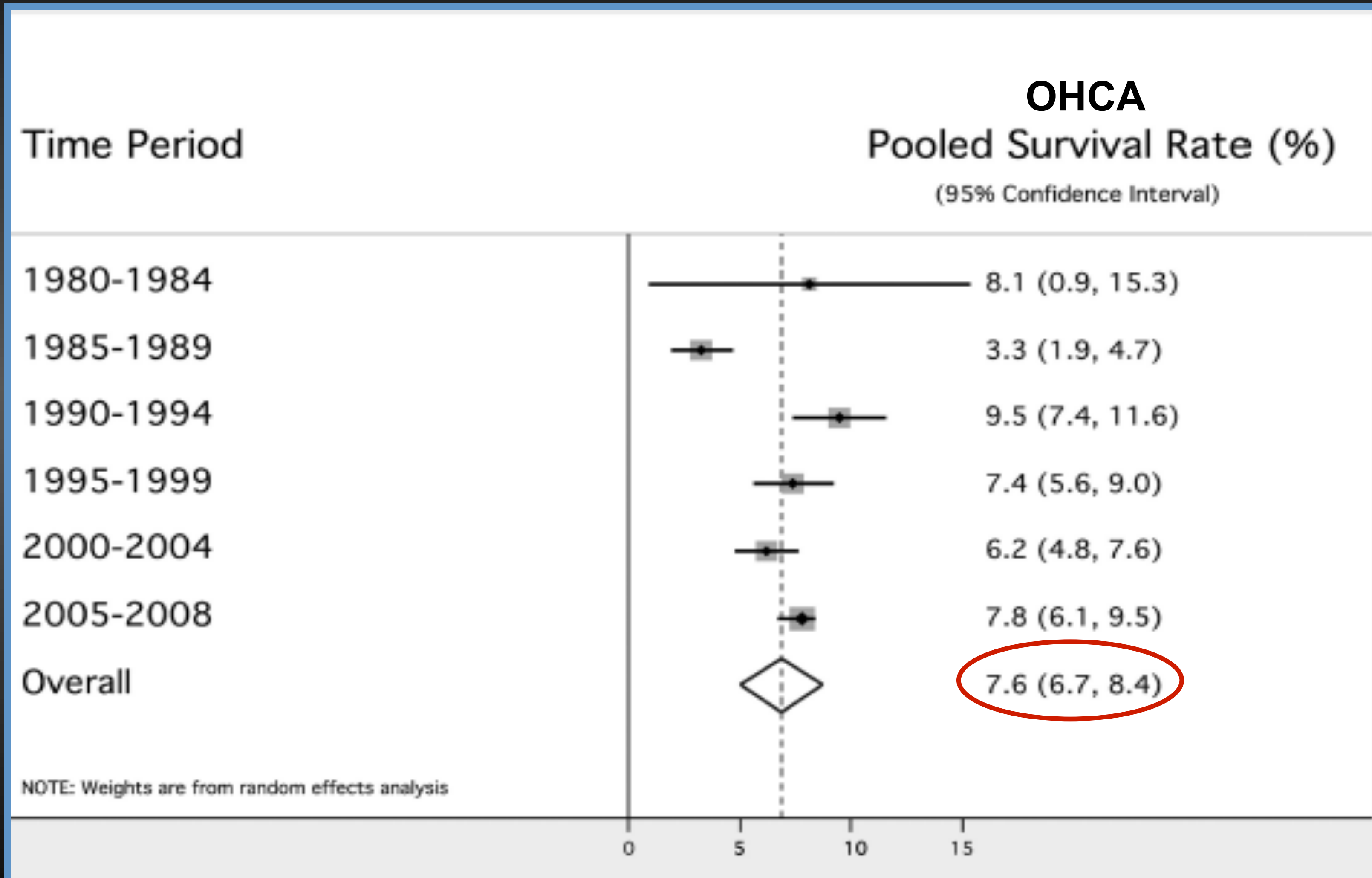
The size of the problem

- ✓ 79 studies involving 142 740 patients
- ✓ 166 000 to 310 000 pts per year
- ✓ Survival rate to hospital admission: 23.8%
- ✓ Survival rate to hospital discharge: 7.6%
- ✓ In-hospital survival: 21-33%

Nichol G. JAMA 2008; 300 (12): 1423-1431

Sasson Circ. Cardiovasc. Qual Outcomes 2010; 3: 63-81

Survival not significantly changed in almost 3 decades



Sasson Circ. Cardiovasc. Qual Outcomes 2010; 3: 63-81

IHCA

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

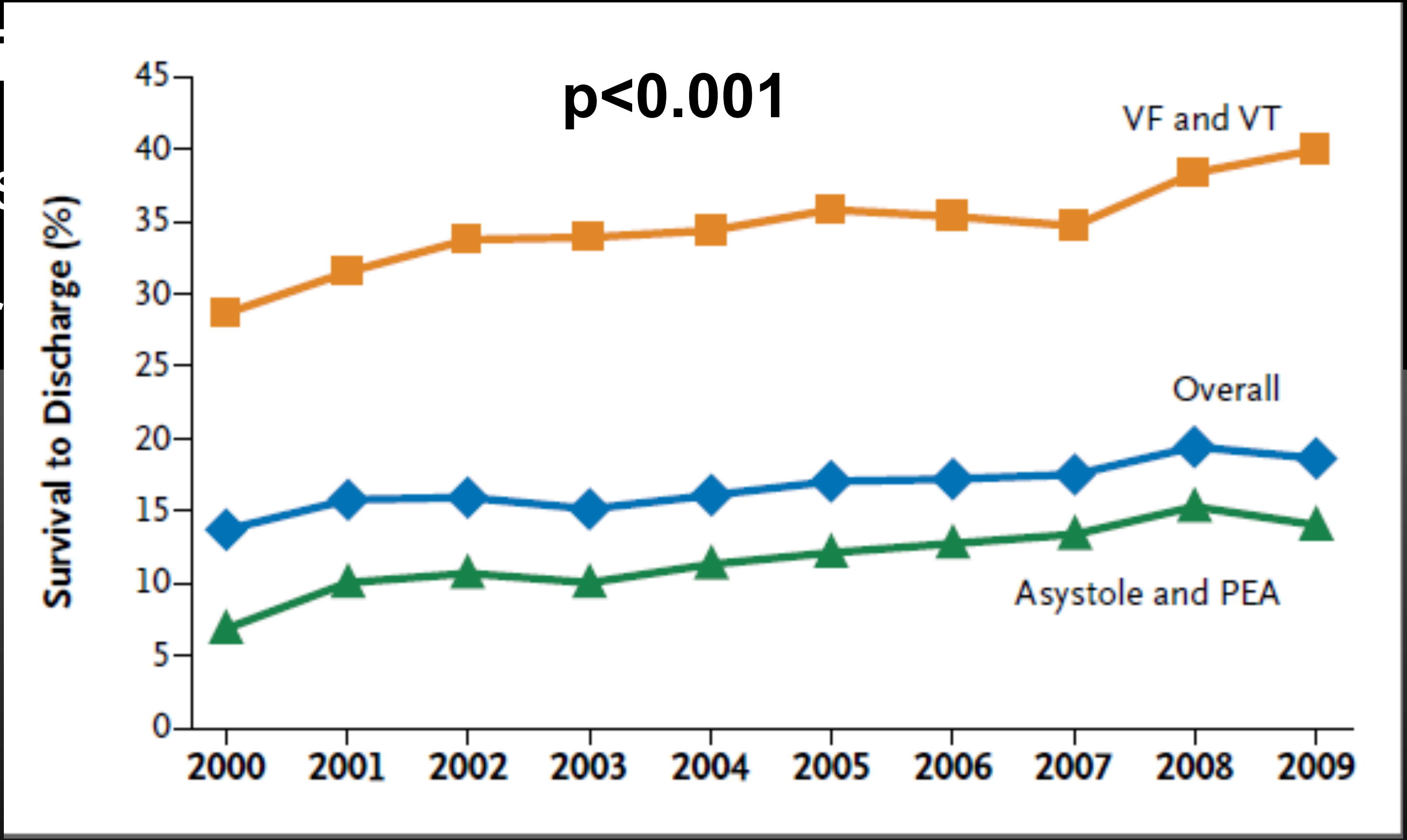
Trends in Survival after In-Hospital Cardiac Arrest

Saket Girotra, M.D., Brahmajee K. Nallamothu, M.D., M.P.H., John A. Spertus, M.D., M.P.H., Yan Li, Ph.D., Harlan M. Krumholz, M.D., and Paul S. Chan, M.D., for the American Heart Association Get with the Guidelines–Resuscitation Investigators

N Engl J Med 2012;367:1912-20

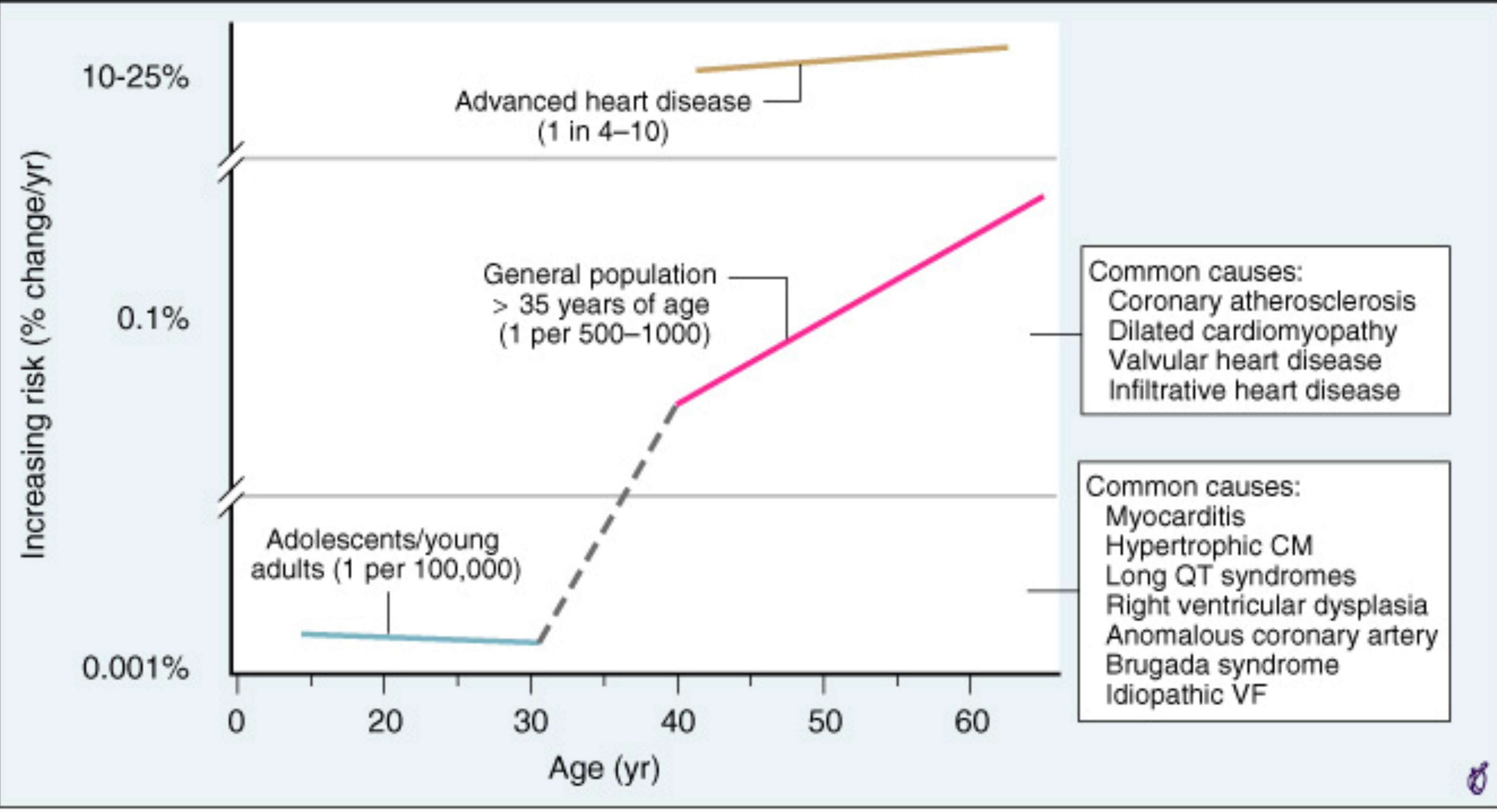
ICHA: the size of the problem

- ✓ 374 hospitals, period 2000>2009
- ✓ 84 625 pati
- ✓ 79.3% asys
- ✓ Overall sur



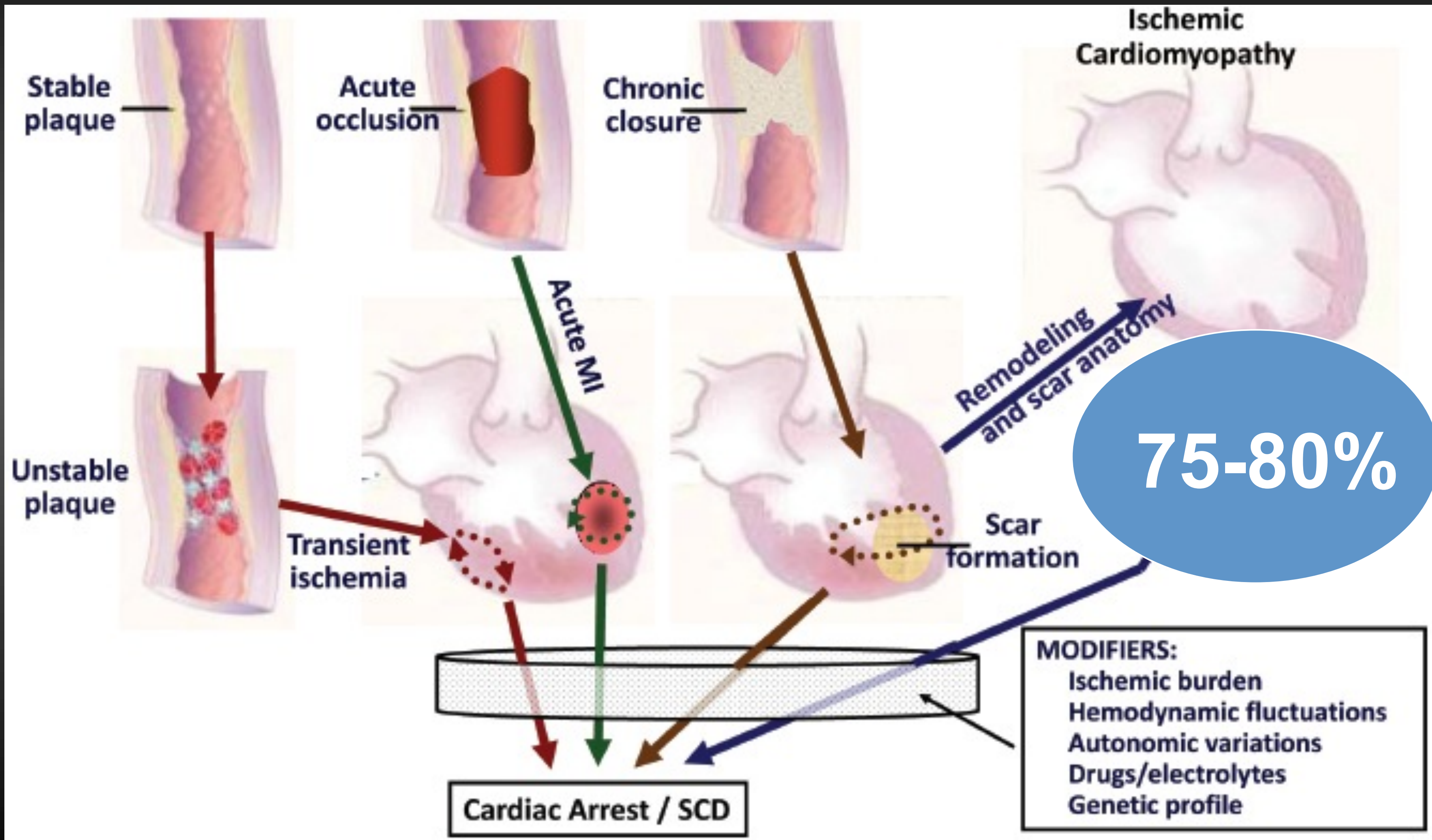
N Engl J Med 2012;367:1912-20

Epidemiology of Sudden Cardicac Death



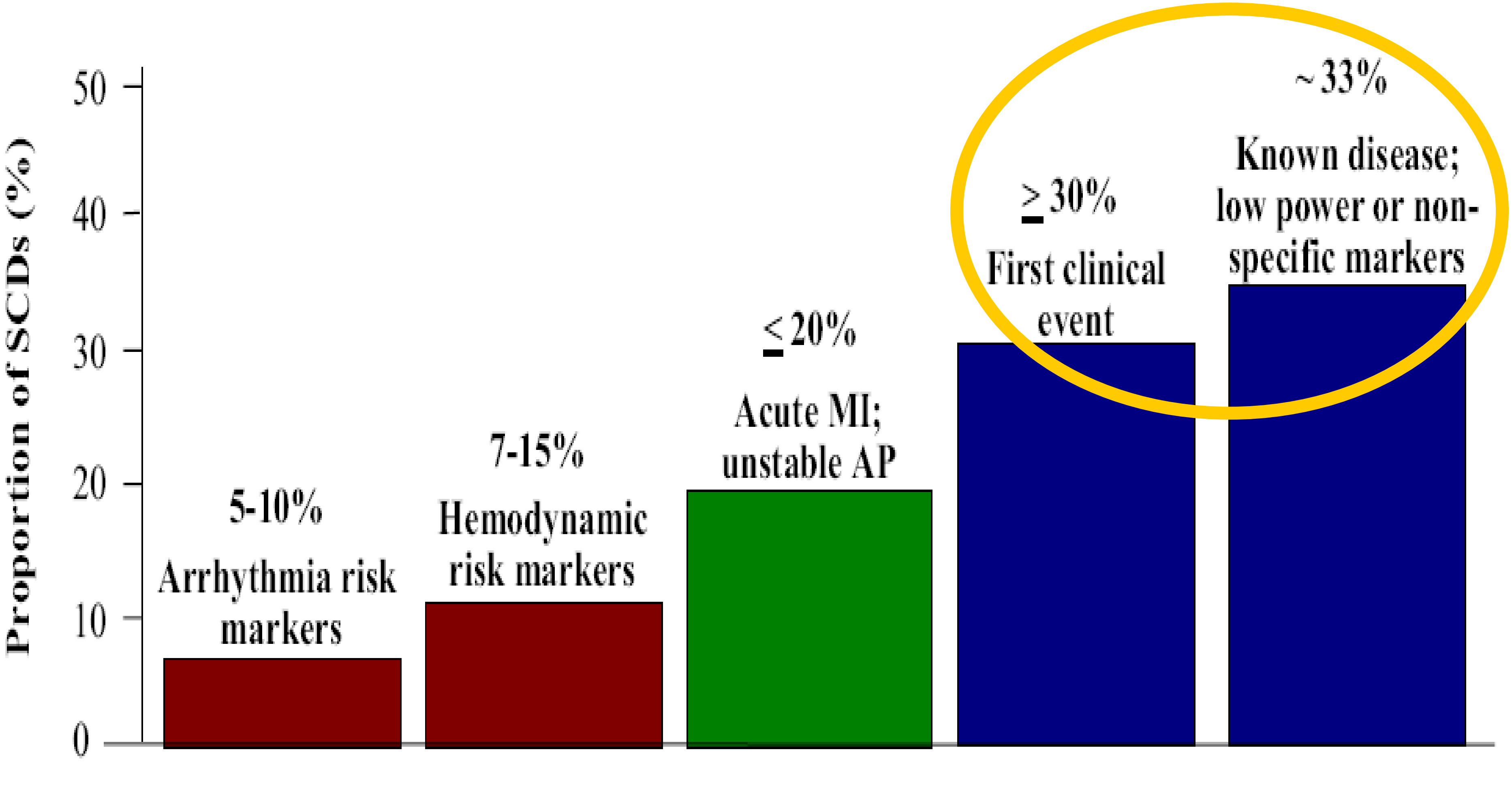
Braunwald's Heart Disease 7th edition

SCD Caused by Coronary Heart Disease



Myerburg RJ. Circulation. 2012;125:1043-1052

Clinical Status of Victims at the Time of SCD

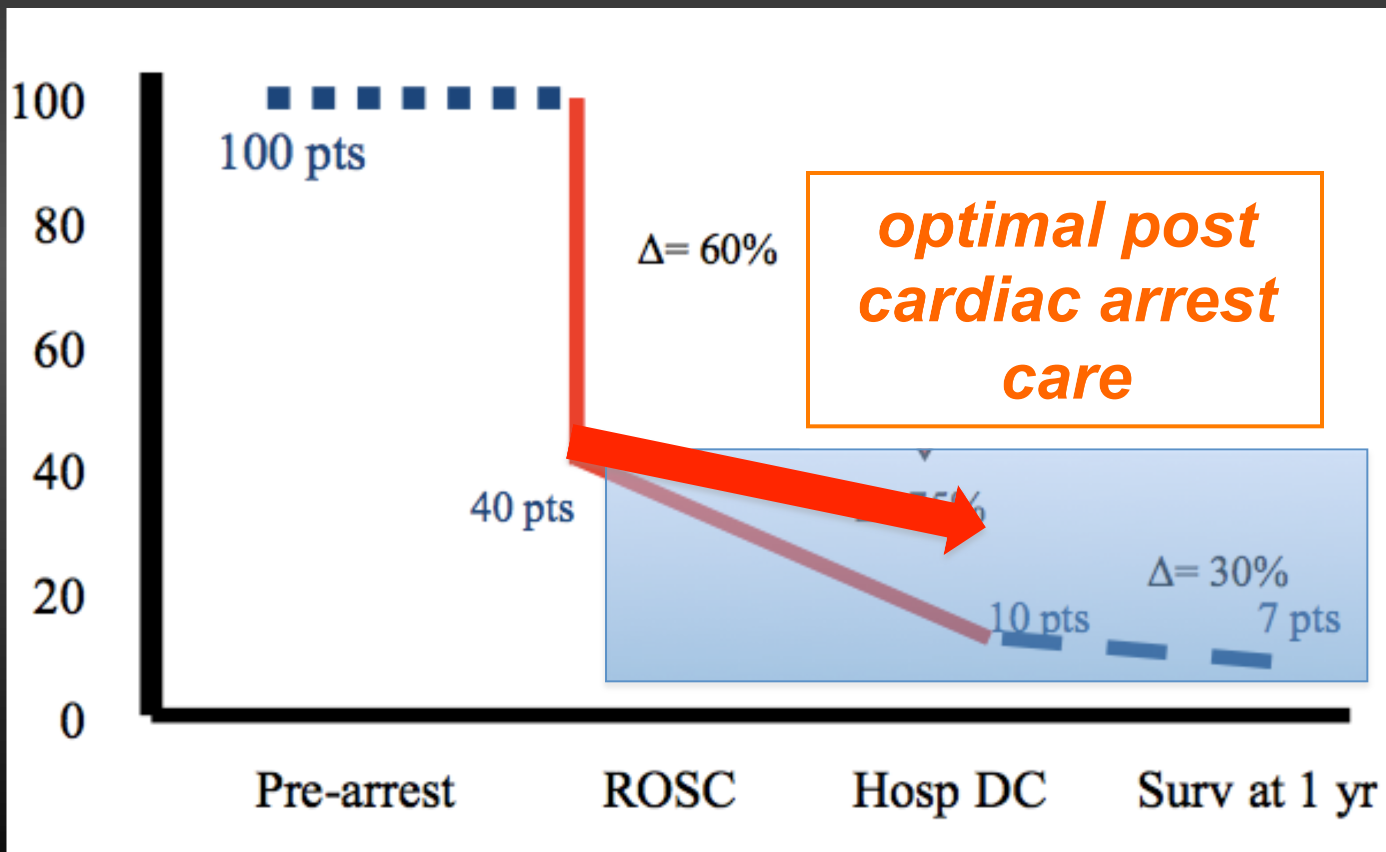


Myerburg RJ. JACC 2009;54:747–63

VIEWPOINT

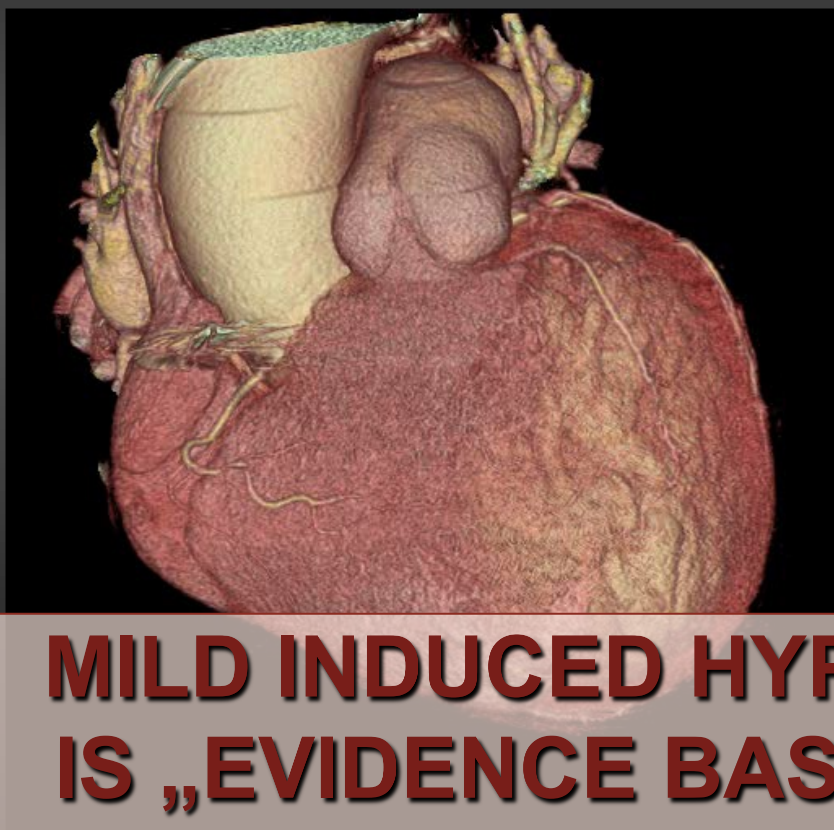
Optimal Treatment of Patients Surviving Out-of-Hospital Cardiac Arrest

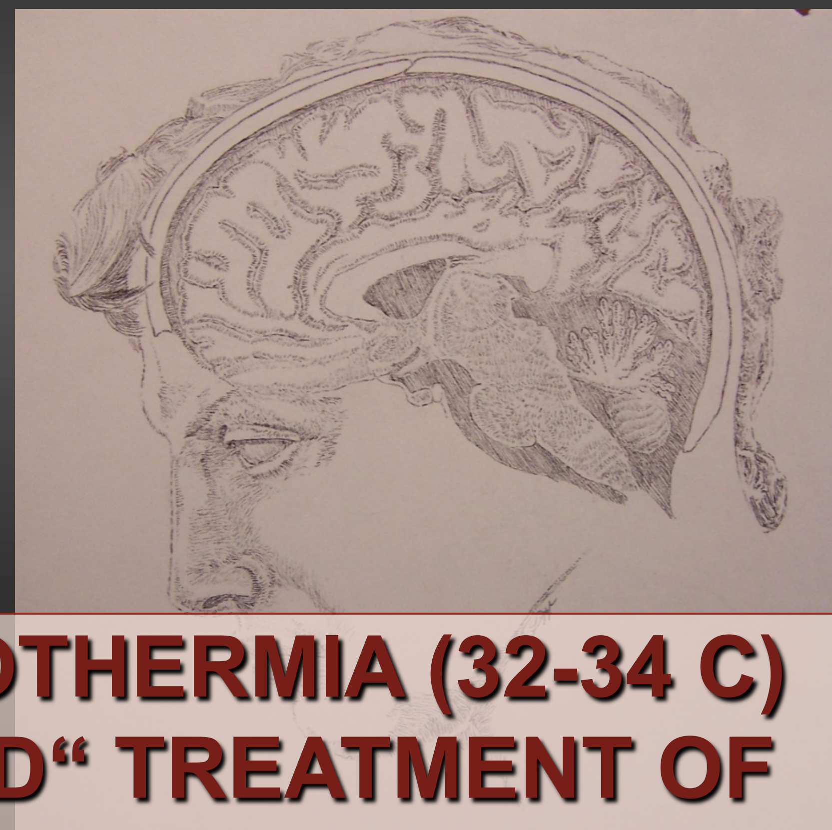
Karl B. Kern, MD



Kern, JACC: Cardiovascular Interventions 2012; Vol 5, Num 6

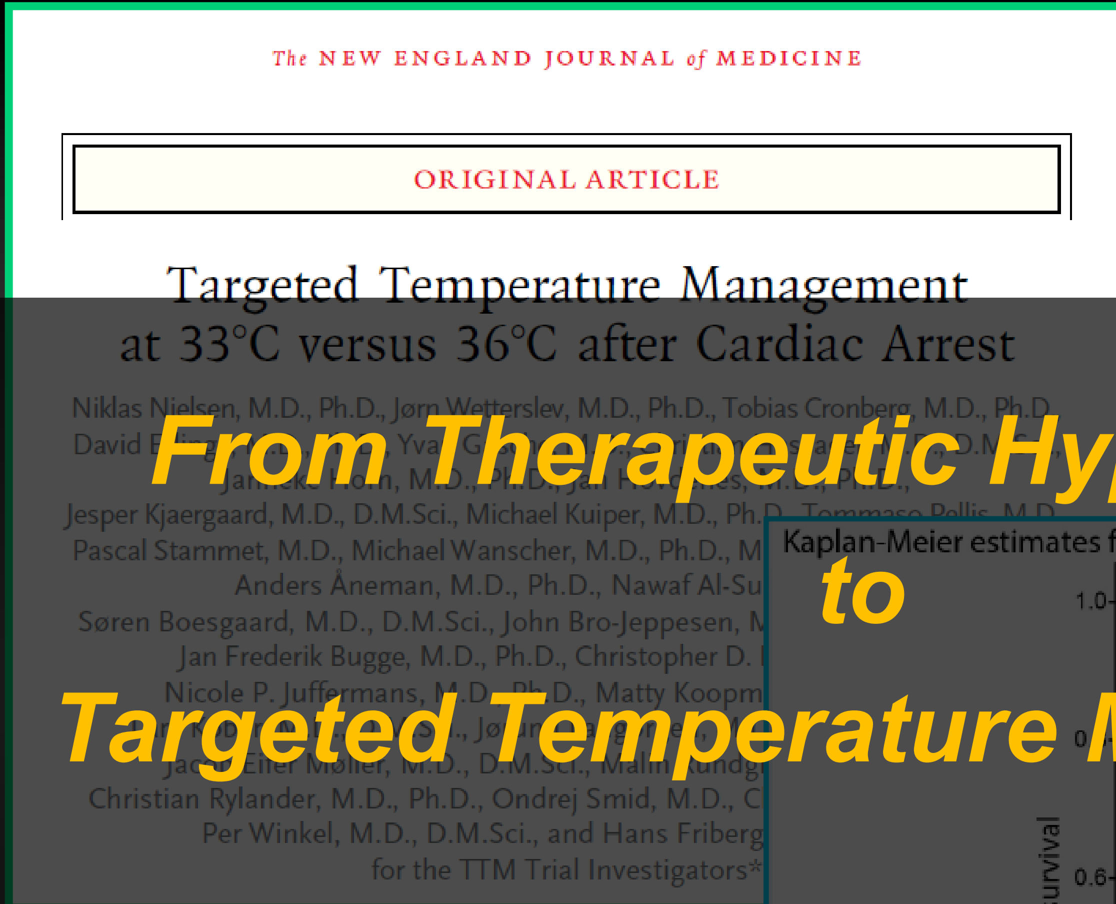
≥ 80% of pts resuscitated from OHCA are comatose





MILD INDUCED HYPOTHERMIA (32-34 C) IS „EVIDENCE BASED“ TREATMENT OF POSTRESUSCITATION BRAIN INJURY

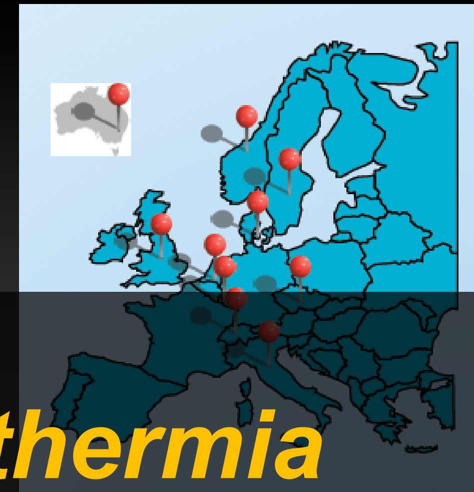
From Therapeutic Hypothermia to Targeted Temperature Management

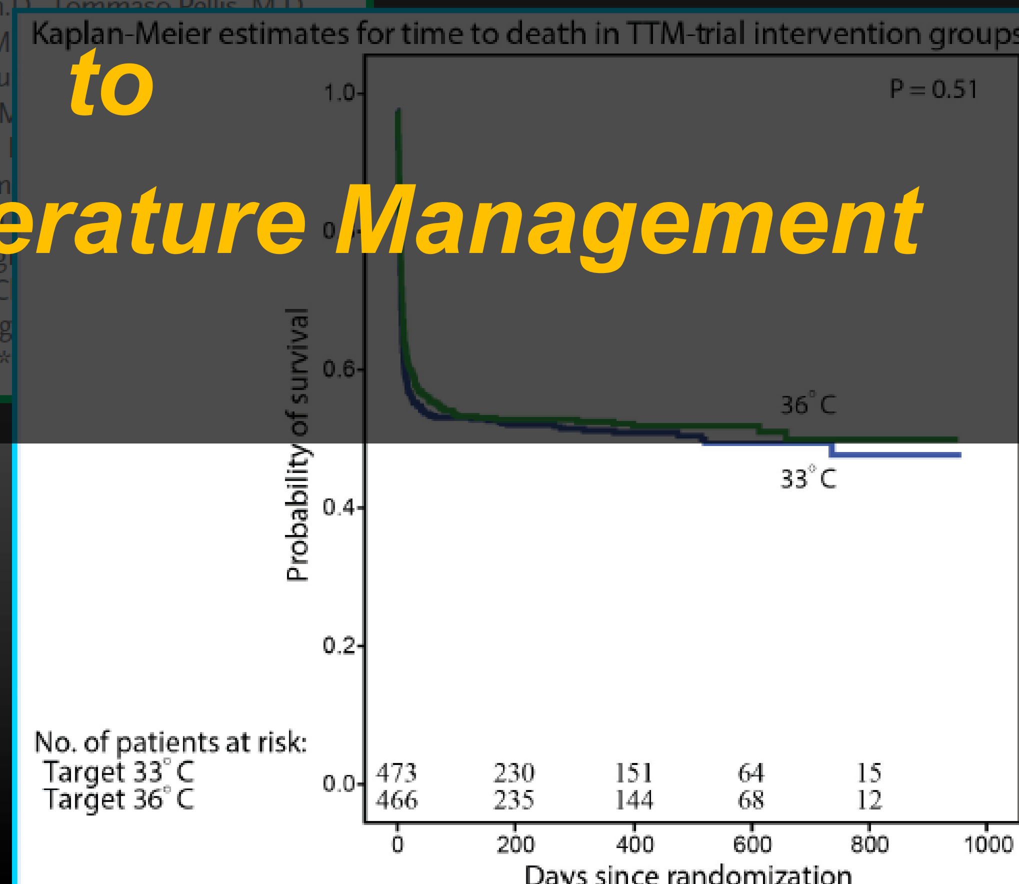

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Targeted Temperature Management at 33°C versus 36°C after Cardiac Arrest

Niklas Nielsen, M.D., Ph.D., Jørn Wetterslev, M.D., Ph.D., Tobias Cronberg, M.D., Ph.D.
Jesper Kjaergaard, M.D., D.M.Sci., Michael Kuiper, M.D., Ph.D., Tommaso Pellis, M.D.
Pascal Stammet, M.D., Michael Wanscher, M.D., Ph.D., M
Anders Åneman, M.D., Ph.D., Nawaf Al-Su
Søren Boesgaard, M.D., D.M.Sci., John Bro-Jeppesen, M
Jan Frederik Bugge, M.D., Ph.D., Christopher D.
Nicole P. Juffermans, M.D., Ph.D., Matty Koopm
Christian Rylander, M.D., Ph.D., Ondrej Smid, M.D., C
Per Winkel, M.D., D.M.Sci., and Hans Friberg
for the TTM Trial Investigators*



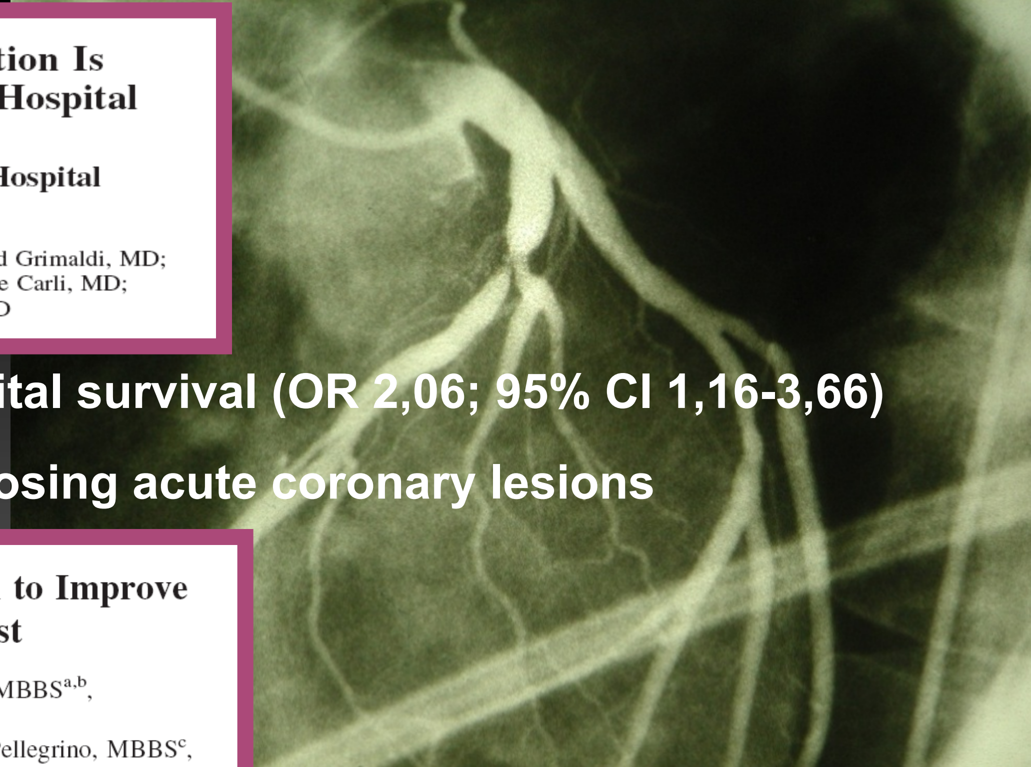


- 939 pts randomized
- 36 hospitals
- Europe/Australia
- 80% VF/VT

Immediate Percutaneous Coronary Intervention Is Associated With Better Survival After Out-of-Hospital Cardiac Arrest

Insights From the PROCAT (Parisian Region Out of Hospital Cardiac Arrest) Registry

Florence Dumas, MD; Alain Cariou, MD; Stéphane Manzo-Silberman, MD; David Grimaldi, MD; Benoît Vivien, MD; Julien Rosencher, MD; Jean-Philippe Empana, MD; Pierre Carli, MD; Jean-Paul Mira, MD; Xavier Jouven, MD; Christian Spaulding, MD



PCI as independent predictor of hospital survival (OR 2,06; 95% CI 1,16-3,66)

Low NPV of post-ROSC ECG in diagnosing acute coronary lesions

Usefulness of Cooling and Coronary Catheterization to Improve Survival in Out-of-Hospital Cardiac Arrest

Dion Stub, MBBS[a,b,*], Christopher Hengel, MBBS[a], William Chan, MBBS[a,b], Damon Jackson, MBBS[a], Karen Sanders, RN, GradDipEd[a], Anthony M. Dart, BA, BM, BCh, DPhil[a,b], Andrew Hilton, MBBS[c], Vincent Pellegrino, MBBS[c], James A. Shaw, MBBS, PhD[a,b], Stephen J. Duffy, MBBS, PhD[a], Stephen Bernard, MBBS, MD[c], and David M. Kaye, MBBS, PhD[a,b]

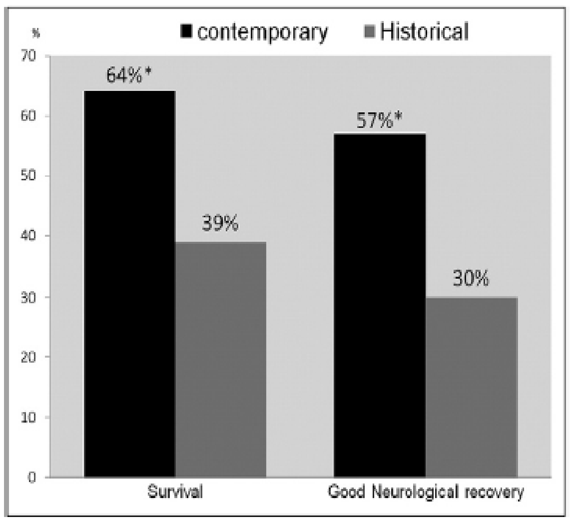


Figure 1. Outcomes based on contemporary *(black bars)* and historical control *(gray bars)* treatment periods (*p <0.01).

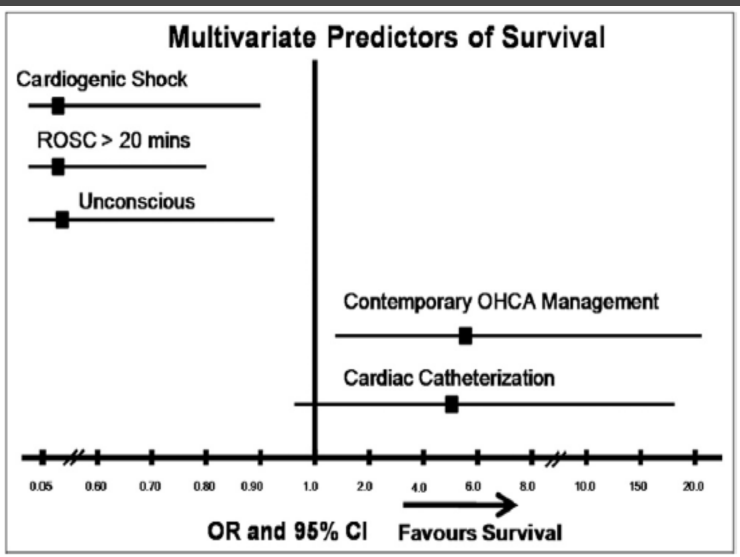
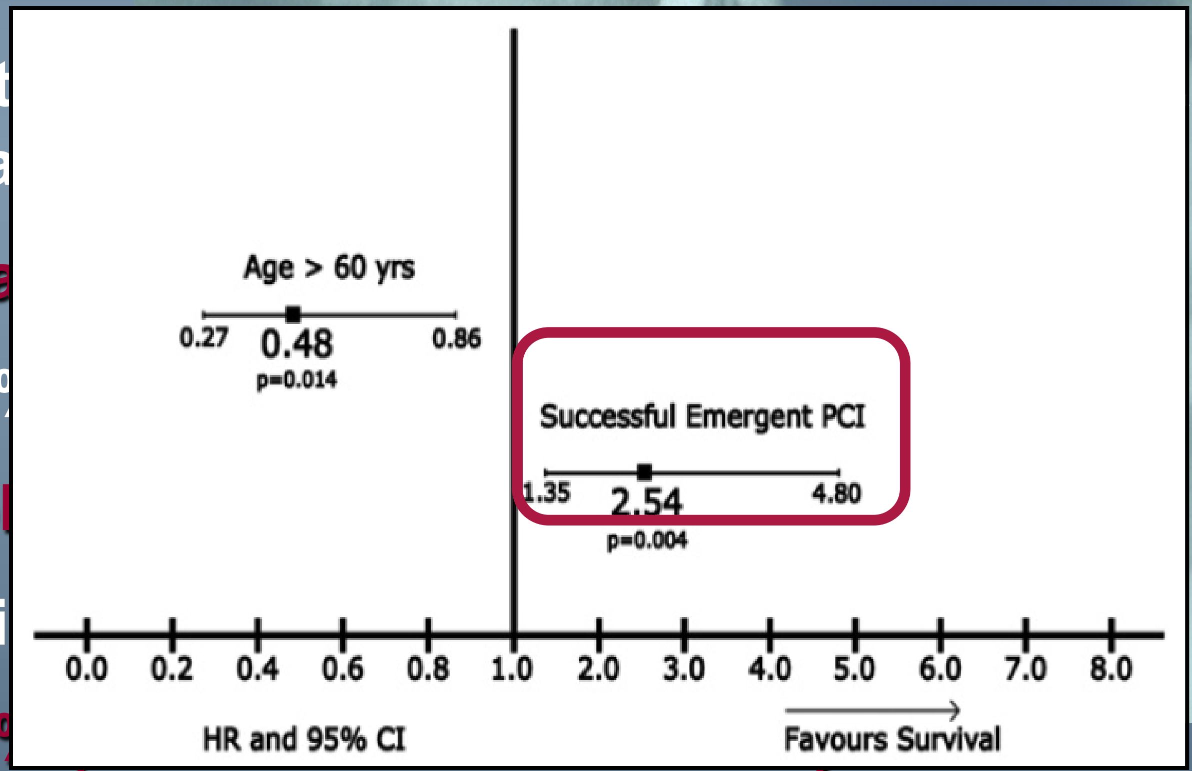


Figure 2. Independent predictors of survival. CI = confidence interval; OR = odds ratio.

Impact of Emergency Coronary Angiography on In-Hospital Outcome of Unconscious Survivors After Out-of-Hospital Cardiac Arrest

Davide Zanuttini, MD[a], Ilaria Armellini, MD[a], Gaetano Nucifora, MD[a,*], Elio Carchietti, MD[b], Giulio Trillò, MD[b], Leonardo Spedicato, MD[a], Guglielmo Bernardi, MD[a], and Alessandro Proclemer, MD[a]

- retrospective study
- 93 unconscious pat
with presumed cardia
- VF/VT 65%, **ST eleva**
- witnessed arrest 84%
- **coronary angiograph**
- culprit coronary lesi
- **hospital survival 54%**



Am J Cardiol 2012;110:1723–1728

Resuscitation 95 (2015) 202–222

Contents lists available at ScienceDirect

Resuscitation

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

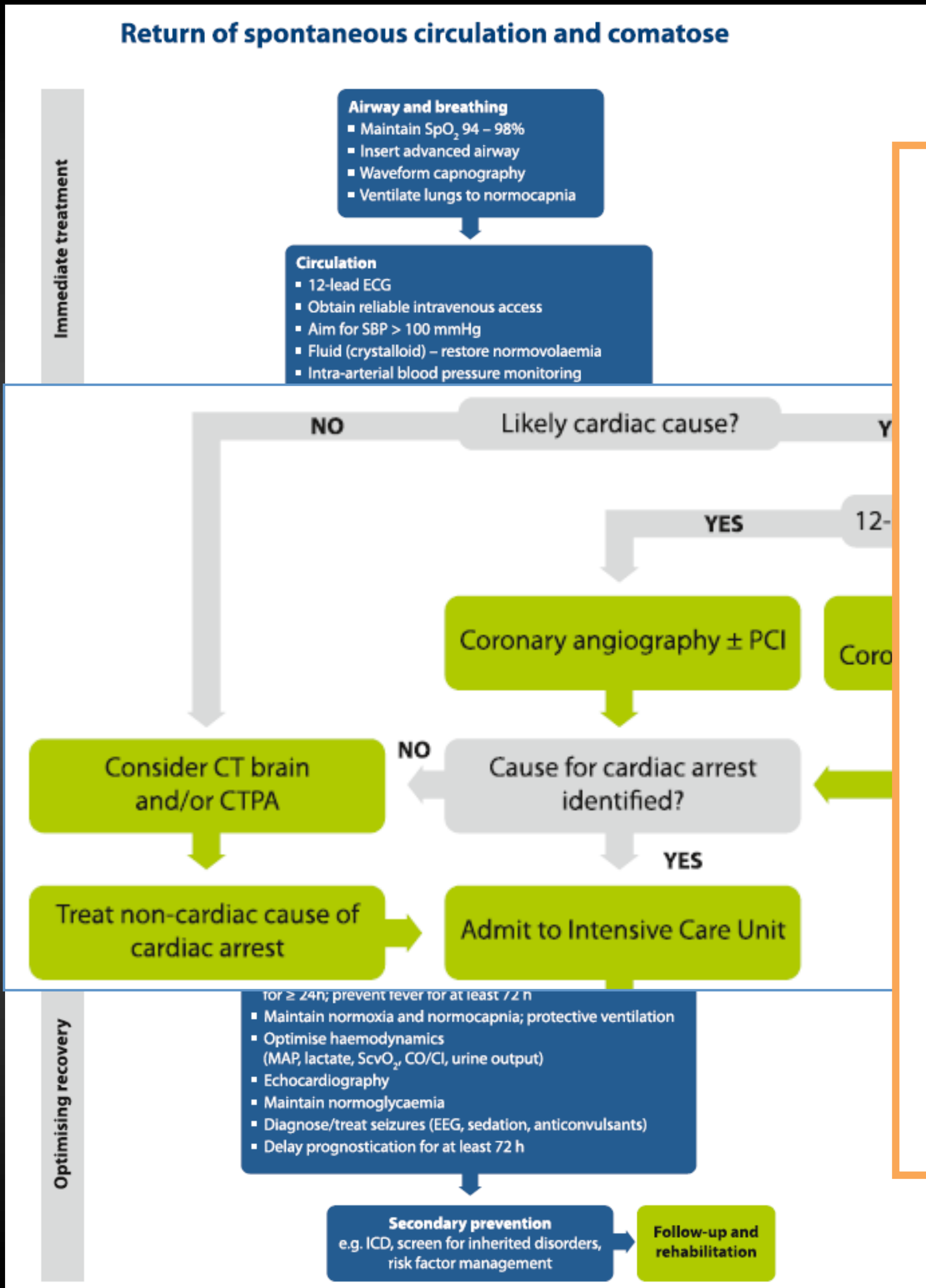
ELSEVIER

EUROPEAN RESUSCITATION COUNCIL

European Resuscitation Council and European Society of Intensive Care Medicine Guidelines for Post-resuscitation Care 2015 Section 5 of the European Resuscitation Council Guidelines for Resuscitation 2015☆

CrossMark

Jerry P. Nolan[a,b,*], Jasmeet Soar[c], Alain Cariou[d], Tobias Cronberg[e], Véronique R.M. Moulaert[f], Charles D. Deakin[g], Bernd W. Bottiger[h], Hans Friberg[i], Kjetil Sunde[j], Claudio Sandroni[k]



Haemodynamic management

Post-resuscitation myocardial dysfunction causes haemodynamic instability, which manifests as hypotension, low cardiac index and arrhythmias.[32,101] Perform early echocardiography in all patients in order to detect and quantify the degree of myocardial dysfunction.[33,102] Post-resuscitation myocardial dysfunction often requires inotropic support, at least transiently. Based on experimental data, dobutamine is the most established treatment in this setting,[103,104] but the systematic inflammatory response that occurs frequently in post-cardiac arrest patients may also cause vasoplegia and severe vasodilation.[32] Thus, noradrenaline, with or without dobutamine, and fluid is usually the most effective treatment. Infusion of relatively large volumes of fluid is tolerated remarkably well by patients with post-cardiac arrest syndrome.[7,8,32] If treatment with fluid resuscitation, inotropes and vasoactive drugs is insufficient to support the circulation, consider insertion of a mechanical circulatory assistance device (e.g., IMPELLA, Abiomed, USA).[7,105]

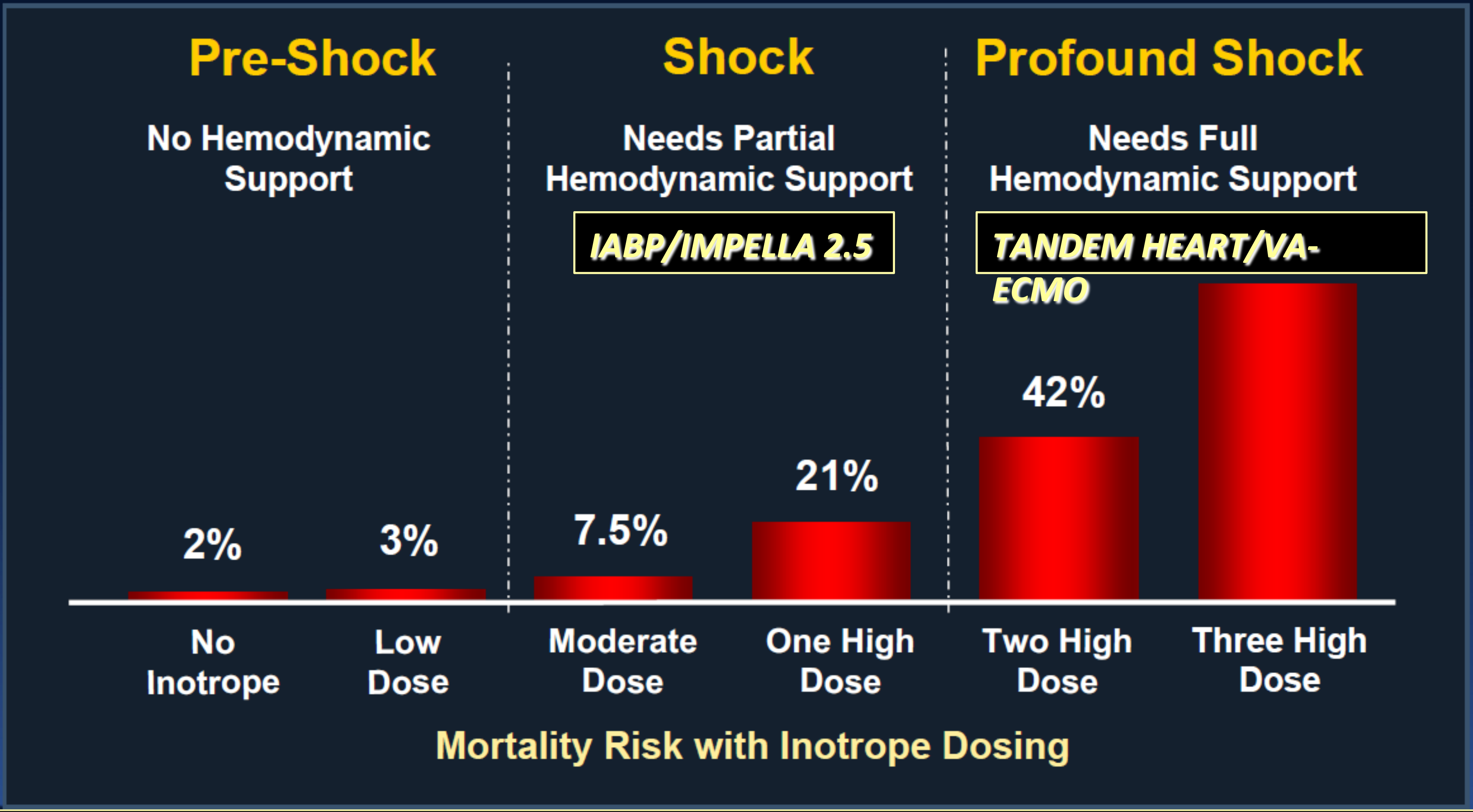
Treatment may be guided by blood pressure, heart rate, urine output, rate of plasma lactate clearance, and central venous oxygen saturation. Serial echocardiography may also be used, especially in haemodynamically unstable patients. In the ICU an arterial line for continuous blood pressure monitoring is essential. Cardiac output monitoring may help to guide treatment in haemodynamically unstable patients but there is no evidence that its use affects outcome. Some centres still advocate use of an intra aortic balloon pump (IABP) in patients with cardiogenic shock, although the IABP-SHOCK II Trial failed to show that use of the IABP improved 30-day mortality in patients with myocardial infarction and cardiogenic shock.[106,107]

Percutaneous Ventricular Assist Devices for Cardiogenic Shock

	IABP	TandemHeart pVAD	Impella 2.5 Recover system	ECMO
Pump mechanism	Pneumatic	Centrifugal	Axial flow	Centrifugal flow
Insertion	Retrograde 7-9F balloon catheter into descending aorta via femoral artery	21F inflow cannula into left atrium via femoral vein and transseptal puncture and 15/17F outflow cannula into femoral artery	12F catheter (13F sheath) placed retrograde across the aortic valve via femoral artery	18–31F inflow cannula into the right atrium via femoral vein and 15-22F outflow cannula into descending aorta via femoral artery
Difficulty of insertion	+	++++	+++	++
Degree of support	+ (⇑ *CO* by 0.5 l/min)	+++ (⇑ *CO* by 3.5–4 l/min)	++ (⇑ *CO* by 2.5 l/min)	++++ (⇑ *CO* to >4.5 l/min)
Cardiac power output[a]	+	+++	++	++++
Time for implantation	10 min	25–65 min	11–25 min	10–15 min
Limb ischemia	+	+++	++	+++
Hemolysis	0	++	++++	+++
Bleeding risks	+	+++	++	++++
Contraindications	Moderate–severe AI/aortic stenosis, coagulopathy, severe sepsis	Peripheral arterial disease (may be placed with antegrade sideport for limb perfusion), RV failure	LV thrombus, ventricular septal defect, severe aortic stenosis, RV failure, peripheral arterial disease	Contraindication to anticoagulation, irreversible brain injury, terminal disease

Curr Opin Cardiol 2011;26:548-554

Cardiogenic Shock is a Spectrum



Curr Opin Cardiol 2011;26:548-554

CURRENT OPINION

Heart rescue: the role of mechanical circulatory support in the management of severe refractory cardiogenic shock

Gabriel T. Sayer[a], Joshua N. Baker[b], and Kimberly A. Parks[a]

Isolated right ventricular failure	Left ventricular failure	Biventricular failure	Coexisting acute lung injury or ARDS
VA ECMO CentriMag RVAD* TandemHeart RVAD*	Impella 5.0 VA ECMO TandemHeart LVAD CentriMag	VA ECMO‡‡ or a combination of one of the following LV support devices: • Impella 5.0 • TandemHeart LVAD • CentriMag‡ Plus, one of the following RV support devices: • CentriMag RVAD** • TandemHeart RVAD**	VA ECMO

Curr Opin Crit Care 2012, 18:409–416

CARDIOHELP

ECMO
Centrifugal flow 18–31F inflow cannula into the right atrium via femoral vein and 15-22F outflow cannula into descending aorta via femoral artery
++
+++++
(⇑ CO to >4.5 l/min)
+++++
10–15 min
+++
+++
++++
Contraindication to anticoagulation, irreversible brain injury, terminal disease

Percutaneous approach in 60% of pts


CARDIOHELP – INSPIRING
INNOVATIONS


MEDECIN
15
SAMU de PARIS


SAMU


POLICE
SAMU
DE
PARIS

Cardiopulmonary resuscitation with assisted extracorporeal life-support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: an observational study and propensity analysis

Yih-Sharng Chen*, Jou-Wei Lin*, Hsi-Yu Yu, Wen-Je Ko, Jih-Shuin Jerng, Wei-Tien Chang, Wen-Jone Chen, Shu-Chien Huang, Nai-Hsin Chi, Chih-Hsien Wang, Li-Chin Chen, Pi-Ru Tsai, Sheoi-Shen Wang, Juey-Jen Hwang, Fang-Yue Lin

Taiwan 2004-2006

- ✓ 172 pts with witnessed IHCA, CPR for longer than 10 min
- ✓Age 18-75 years
- ✓ Average duration from call to ECMO team arrival 5-7min (day), 15-30 (night)
- ✓ 10-15 min needed to set up ECMO

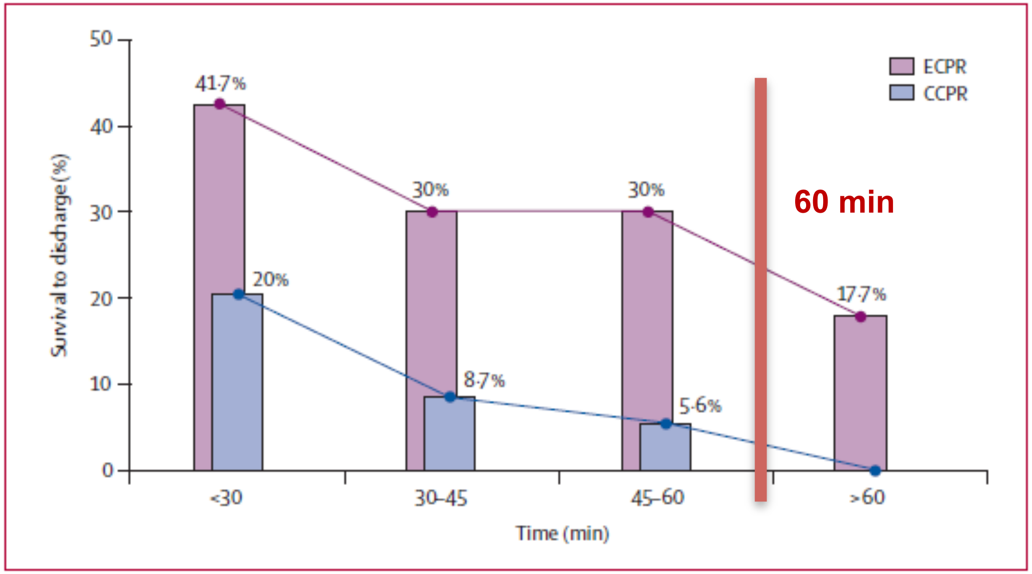
Extracorporeal CPR 59 pts

Conventional CPR 113 pts

Lancet 2008;372:554-61

	E-CPR 59 pts	C-CPR 113 pts	
Causes of arrest, n (%)			
Acute coronary syndrome	37 (62·7)	80 (70·8)	
Congestive heart failure	6 (10·2)	18 (15·9)	
Myocarditis	5 (8·5)	2 (1·8)	
Post-cardiotomy	7 (11·9)	0	
Pulmonary embolism	1 (1·7)	0	
Unspecified cardiac causes	3 (5·1)	13 (11·5)	
First documented rhythm			
Ventricular tachycardia/ventricular fibrillation	29 (49·2)	36 (31·9)	
Pulseless electrical activity	17 (28·8)	46 (40·7)	
Asystole	13 (22·0)	31 (27·4)	
Subsequent intervention			
Yes	36 (61·0)	14 (12·4)	<0·0001
Revascularisation	26 (44·1)	6 (6·4)	<0·0001
Ventricular assist device	3 (5·1)	0 (0)	0·04
Heart transplantation	5 (8·5)	0 (0)	0·004
Extracorporeal life support		3 (3·1)	
Reperfusion for distal limb	15 (25·4)	··	<0·0001

Lancet 2008;372:554-61



	Hazard ratio	95% CI	p
Ventricular tachycardia/ ventricular fibrillation	0·58	0·40–0·83	0·003
Use of extracorporeal membrane oxygenation	0·50	0·33–0·74	0·001
CPR duration (+1 min)	1·007	1·003–1·011	0·002
Age (+1 year)	1·01	0·99–1·02	0·07
Men	1·04	0·72–1·5	0·83
Period C (midnight)	1·05	0·71–1·5	0·82
Intensive scenario	1·1	0·78–1·6	0·58

Intensive scenario=intensive care unit, operating room, or catheterisation room.

Table 4: **Multivariate Cox regression analysis for the factors associated with the survival to hospital discharge**

ROSC (ROSB)	55 (93·2)	63 (55·8)	<0·0001
CPR duration			
N	59	113	
Mean (SD), min	52·8 (37·2)	42·7 (31·1)	0·08

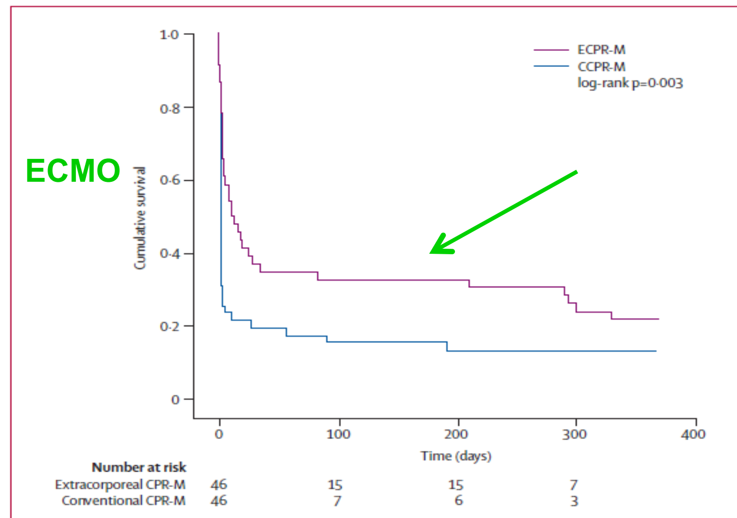


Figure 3: **Kaplan-Meier plot of the survival curves in the extracorporeal CPR-M and conventional CPR-M groups for 1 year**

Lancet 2008;372:554-61

Resuscitation 81 (2010) 968–973

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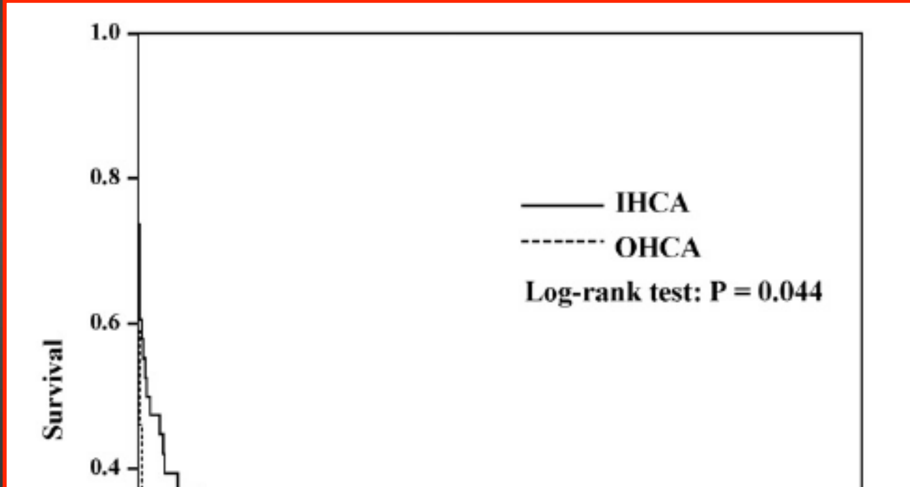
Resuscitation

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

Clinical paper

Assessment of outcomes and differences between in- and out-of-hospital cardiac arrest patients treated with cardiopulmonary resuscitation using extracorporeal life support☆

- 77 ECMO teated refractory CA (38 IHCA, 39 OHCA)
- Age: 18-74
- Presumed cardiac origin or pulmonary embolism
- Estimated no-flow time < 15 min



Multivariate stepwise Cox regression analysis for the factors associated with the 30-day and 1-year survival.

	Odds ratio	95% confidence interval	*p* value
30-day survival			
Out-of-hospital cardiac arrest	0.94	0.68–1.27	0.67
Time interval from collapse to start of extracorporeal life support (every 1 min)	0.98	0.96–0.99	<0.01
Initial rhythm of ventricular fibrillation	1.32	1.00–1.78	0.048
1-year survival			
Out-of-hospital cardiac arrest	0.99	0.73–1.33	0.95
Time interval from collapse to start of extracorporeal life support (every 1 min)	0.98	0.96–0.99	<0.01
Initial rhythm of ventricular fibrillation	1.28	0.98–1.70	0.07

Resuscitation 85 (2014) 1219–1224

Contents lists available at ScienceDirect

Resuscitation

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

Clinical Paper

Taiwan 2007-2012

Improved outcome of extracorporeal cardiopulmonary resuscitation for out-of-hospital cardiac arrest – A comparison with that for extracorporeal rescue for in-hospital cardiac arrest☆,☆☆

- ✓ 230 ECMO for witnessed cardiac arrest > ECPR
- ✓ Age 16-79 years
- ✓ Inclusion criteria: CPR > 10min without ROSC
- ✓ Mean duration of ischemia: 67 min OHCA; 44 min IHCA

OHCA ECPR 31 pts	IHCA ECPR 199 pts

	OHCA 31 pts	IHCA 199 pts	
Disease diagnosed, possible cause			
Deteriorated cardiomyopathy	0 (0)	31 (15.6)	0.01
Acute coronary syndrome	19 (61.3)	85 (42.7)	0.04
Hypovolumia	2 (6.5)	9(4.5)	0.64
Suspected myocarditis	1 (3.2)	11 (5.5)	0.59
Electric shock/CO poisoning	3 (9.7)	0 (0)	
Drug/electrolyte effect	2 (6.5)	6 (3.0)	0.33
Pulmonary embolism		6 (3.0)	0.33
Postcardiotomy/post-HTx		18 (9.0)	0.08
Others	4 (12.9)	33 (16.6)	0.60
Subsequent intervention			
Yes	18 (58.1)	96 (48.2)	0.31
Revascularization	18 (58.1)	68 (34.2)	0.01
Outcome			
Duration of ECMO			
Mean	61.1 ± 48.2	94.4 ± 122.3	<0.01
Median	63.3	49.4	
Survival to discharge	12 (38.7)	62 (31.2)	0.26
CPC status at discharge			
1 or 2, *n* (%)	8 (25.8)	50 (25.1)	0.55

Resuscitation 85 (2014) 1219–1224

Our consecutive series demonstrated that, despite some possible selection bias, the use of ECPR resulted in similar outcomes for IHCA and OHCA patients. The improved outcome in the OHCA group when ECPR was applied within 75 min should encourage further studies in this field and suggests that ECMO might be considered as an adjuvant therapy for not only IHCA, but also for OHCA.

to a selection or publication bias. The better outcome seen in our study may be related to the following: (1) There is a well-organized and rapid-response EMT system in Taipei city.[25] (2) Our facility is centrally located and adept at handling patient transportation and resuscitation. (3) We designed a protocol to initiate ECPR for OHCA using an equipped cart in the emergency room, rather than in the ICU, shortening the duration of ischemia to a mean of 67 min, shorter than the 88–120 min seen in other series.[19,21]

Resuscitation 85 (2014) 1219–1224

Interventional Cardiology

Hiroshima 2004-2011

Should We Emergently Revascularize Occluded Coronaries for Cardiac Arrest?

Rapid-Response Extracorporeal Membrane Oxygenation and Intra-Arrest Percutaneous Coronary Intervention

ECPR + intra-arrest PCI -> ROSB (return of spontaneous heartbeat)

ECPR PROTOCOL

- Refractory IHCA and OHCA (no ROSC within 20 min)
- Age: 18-74 (median age 63 y)
- Presumed cardiac origin or pulmonary embolism
- Estimated no-flow time < 15 min
- ECMO in the Cath Lab
- Coronary angiography for all pts
- PCI when needed

Circulation 2012; 126: 1605–13

Table 1. Baseline Clinical and Angiographic Characteristics of Study Patients

86 ACS

	All (n=86)	Intra-Arrest PCI (n=61)	Non–Intra-Arrest PCI (n=25)	*P* Value
Age, y	63 (56–72)	63 (56–72)	66 (50–74)	0.90
Male	70 (81)	48 (79)	22 (88)	0.38
Out-of-hospital cardiac arrest	42 (49)	29 (48)	13 (52)	0.71
Initial recorded rhythm				
Pulseless ventricular tachycardia/ventricular fibrillation	46 (53)	34 (56)	12 (48)	0.51
Nonshockable rhythm	40 (47)	27 (44)	13 (52)	
Witnessed cardiac arrest	77 (90)	58 (95)	19 (76)	0.02
Bystander CPR	67 (80)	50 (85)	17 (68)	0.08
Collapse to CPR, min	1 (0–3)	1 (0–3)	1 (0–8)	0.18
Collapse to initiation of ECMO, min	49 (30–68)	45 (27–68)	55 (40–67)	0.24
ST-segment elevation myocardial infarction	32 (37)	32 (52)	0 (0)	<0.001
Non–ST-segment elevation myocardial infarction	54 (63)	29 (48)	25 (100)	<0.001
Emergency coronary angiography	81 (94)	61 (100)	20 (80)	0.002
Intra-aortic balloon pump	71 (83)	57 (93)	14 (56)	<0.001
Outcomes				
ROSB	76 (88)	61 (100)	15 (60)	<0.001
Weaning from ECMO	43 (50)	36 (59)	7 (28)	0.009
30-d survival	25 (29)	22 (36)	3 (12)	0.03
Favorable neurological outcome	21 (24)	20 (33)	1 (4)	0.005

Circulation 2012; 126: 1605–13

	Survival (n = 25)	Death (n = 61)	*P Value*
OHCA	7 (28)	35 (57)	0.01
Collapse to ECMO, min	40 (25-51)	54 (34-74)	0.002

Conclusions
Rapid-response ECMO plus intra-arrest PCI is associated with a higher survival rate in patients who are unresponsive to conventional CPR. PCI is feasible in this setting, may increase the rate of ROSB, and may improve survival. Early initiation of ECMO may improve outcomes in refractory cardiac arrest patients. On the basis of these findings, randomized studies of rapid-response ECMO and intra-arrest PCI in refractory cardiac arrest patients with the complication of ACS are needed to answer the question of whether we should emergently revascularize occluded coronary arteries for refractory cardiac arrest patients.

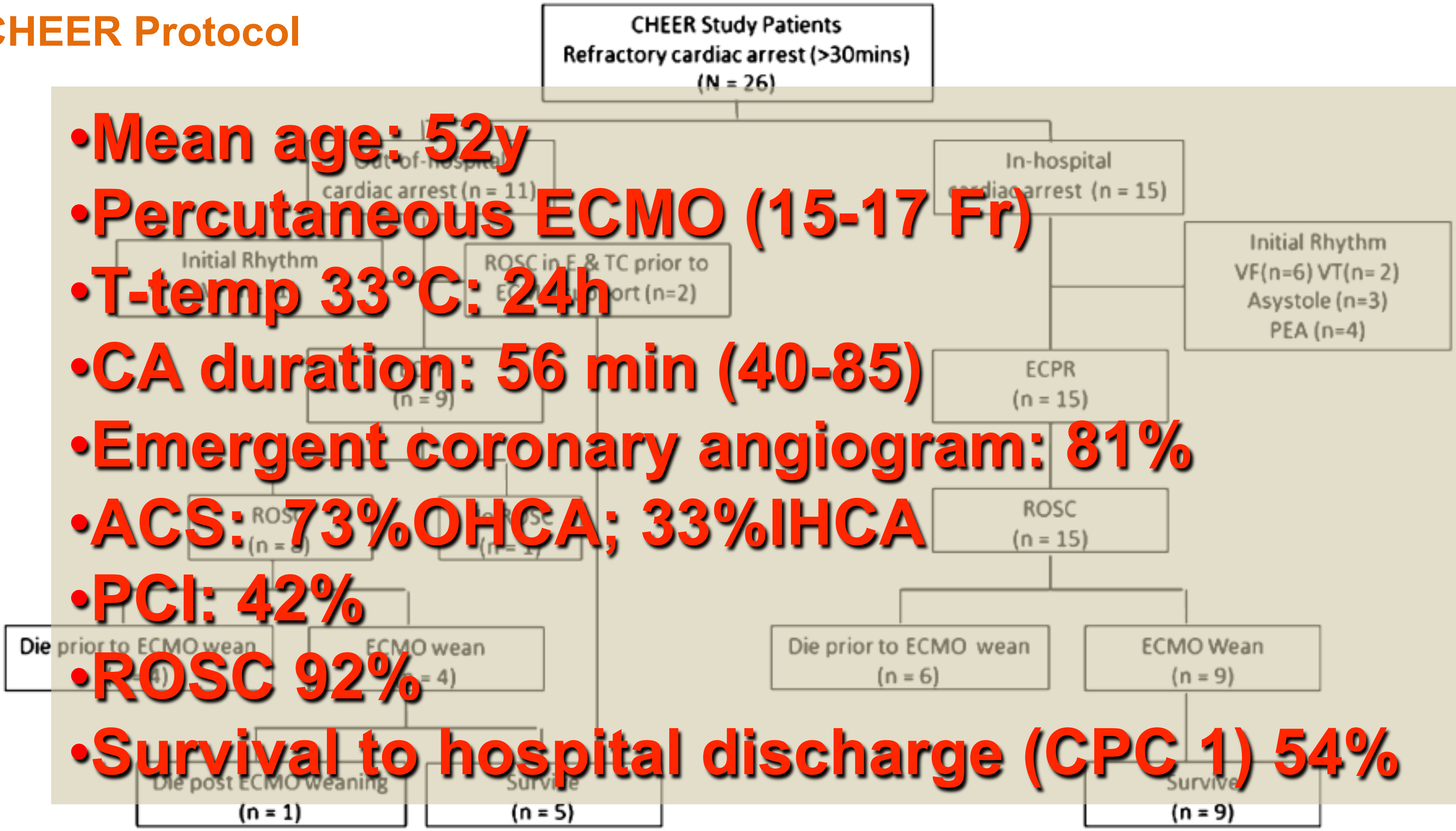
Circulation 2012; 126: 1605–13

Clinical Paper

Refractory cardiac arrest treated with mechanical CPR, hypothermia, ECMO and early reperfusion (the CHEER trial)☆

Melbourne

CHEER Protocol



- •Mean age: 52y
- •Percutaneous ECMO (15-17 Fr)
- •T-temp 33°C: 24h
- •CA duration: 56 min (40-85)
- •Emergent coronary angiogram: 81%
- •ACS: 73%OHCA; 33%IHCA
- •PCI: 42%
- •ROSC 92%
- •Survival to hospital discharge (CPC 1) 54%

Resuscitation 86 (2015): 88-94

Editorial

Extra-corporeal cardiopulmonary resuscitation – Miracle cure or expensive futility?

- ✓ **ECPR improves outcome in both refractory OHCA and IHCA pts**
- ✓ **Patients selection is crucial (witnessed CA, short no-flow time, rapid transport, short CA duration)**
- ✓ **The combination of ECPR and intra-arrest PPCI is related with higher survival rate**

Clinical Case

December 14th

- Female, 33 years old
- Suspected Brugada Syndrome
- Aymaline Challenge -> Cardiac arrest due to refractory VF (8 DC-shock without efficacy)
- Conventional CPR followed by mechanical chest compression (Lucas)

↓

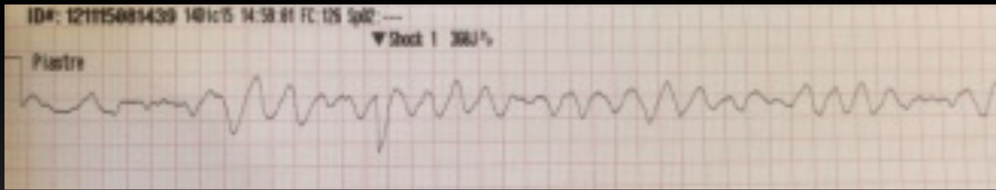
- Transport to our Center during ongoing CPR (Lucas)
- Surgical v-a ECMO insertion
- Estimated low-flow time 150 min

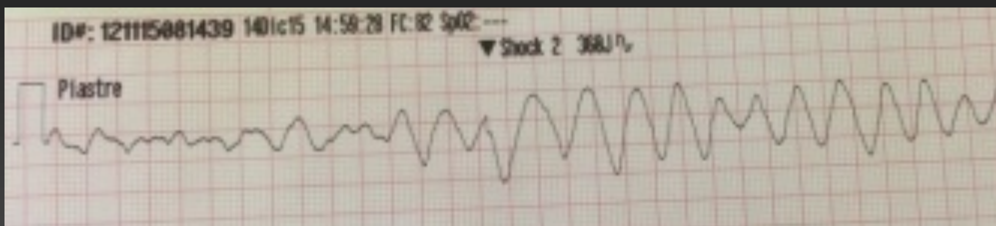
Long lasting VF

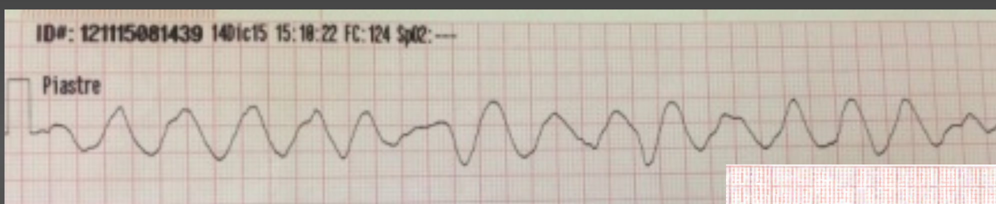
2 DC 360J shock

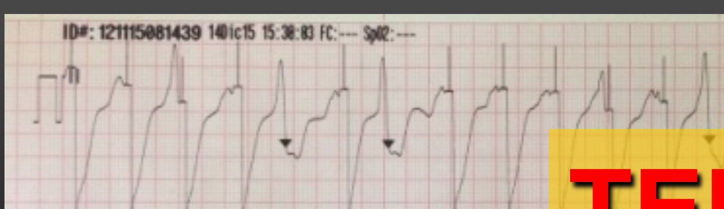
Amiodarone 300 mg
Calcium Chloride + Potassium Chloride
+
Starting ECMO

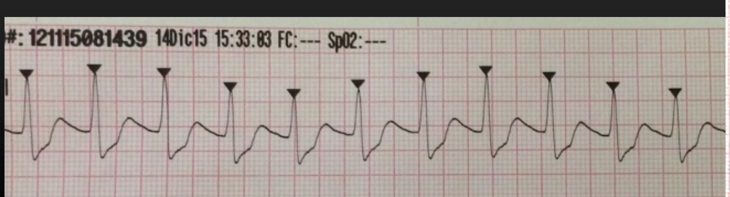
Conversion to slow Idioventricular Rhythm

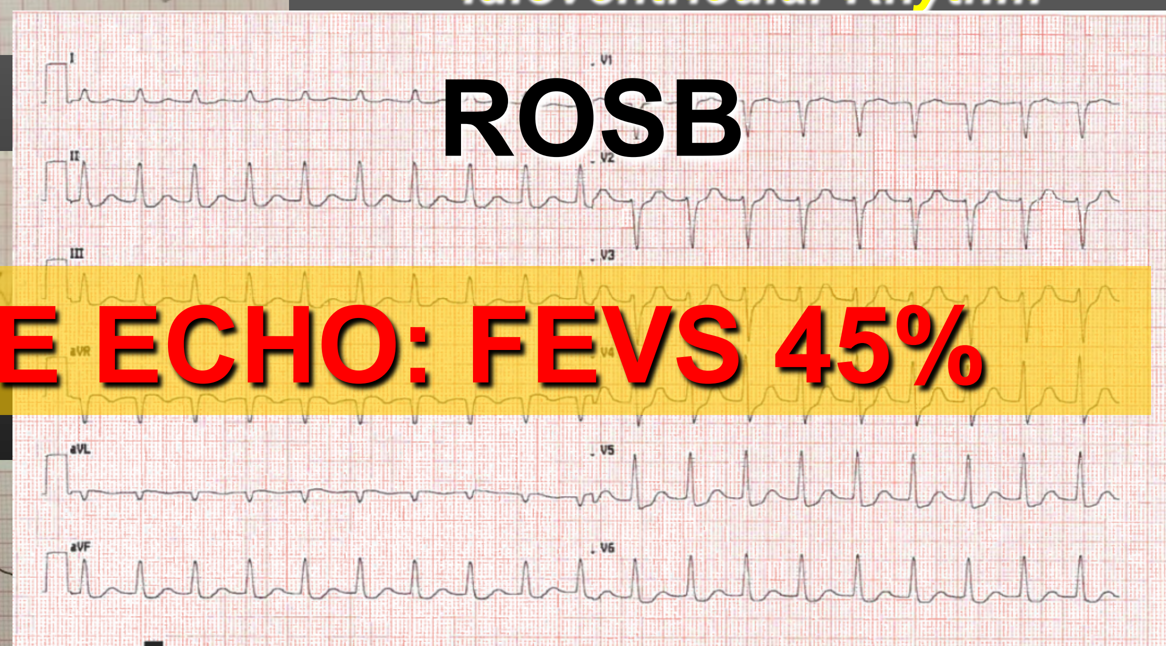












ROSB

TEE ECHO: FEVS 45%

Day 1

- ECMO 4.5 l/min + IABP + Levosimendan 12h + Sodium Nitroprusside
- Hypothermia (34°C) 10h
- Lab: TnI max 101 ng/ml, Cr 0.8 mg/dl, AST 440 U/l, ALT 422 U/l

Day 2

- Progressive ECMO weaning + IABP
- Awake
- Echocardiography: LVEF 45%

Day 3

- ECMO 2.5 l/min + IABP
- Lab: TnI 28 ng/ml, Cr 0.98 mg/dl, AST 141 U/l, ALT 149 U/l……

Need for multicenter perspective registries