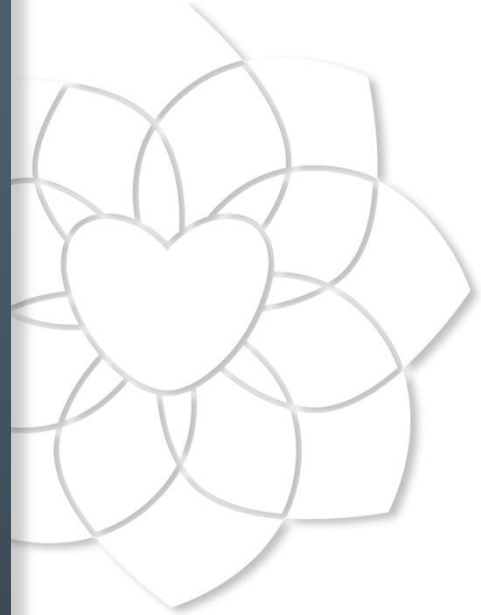


State of the art lecture:
**21st Century Post
resuscitation management**

ACCA Masterclass 2017

Prof Alain CARIOU
Intensive Care Unit - Cochin Hospital (APHP)
Paris Descartes University – INSERM U970 - France

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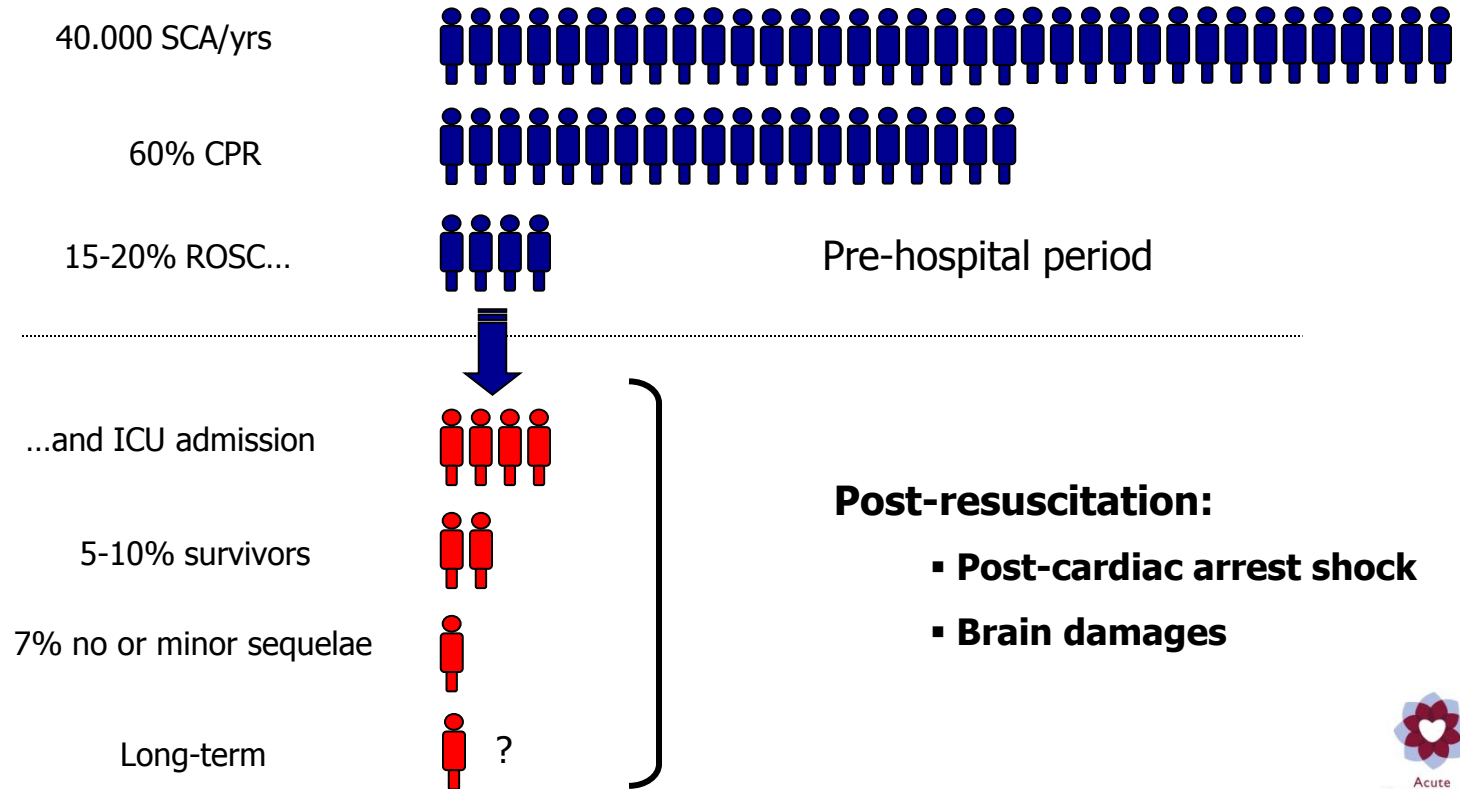
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COI disclosure

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- **Bard** (fees for conferences)

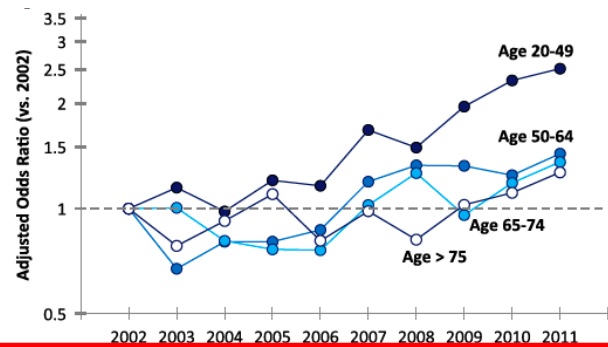
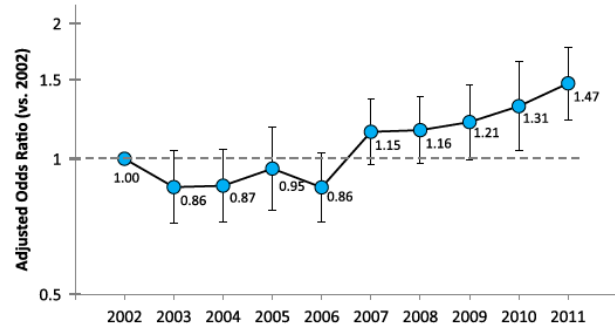
The challenge is not only before hospital arrival!



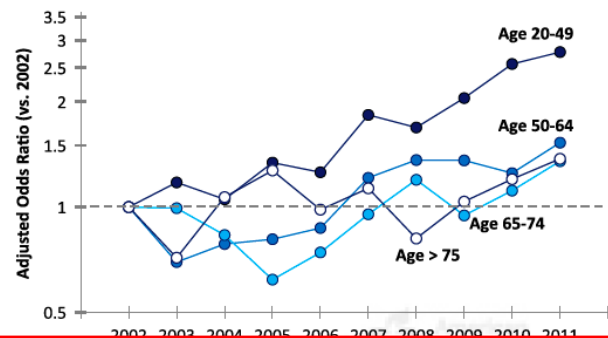
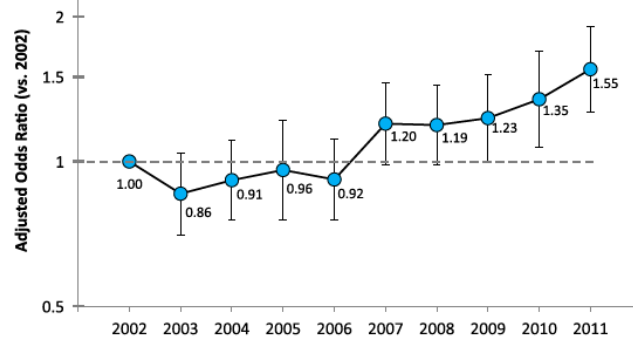
Trends in Short- and Long-Term Survival Among OHCA Patients Alive at Hospital Arrival

Wong MKY et al. *Circulation* 2014

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30-days



1-year



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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[☆]

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 Fribergⁱ,
Kjetil Sunde^j, Claudio Sandroni^k



Intensive Care Med
DOI 10.1007/s00134-015-4051-3

CONFERENCE REPORTS AND EXPERT PANEL



Jerry P. Nolan
Jasmeet Soar
Alain Cariou
Tobias Cronberg
Véronique R. M. Moulaert
Charles D. Deakin
Bernd W. Bottiger
Hans Friberg
Kjetil Sunde
Claudio Sandroni

European Resuscitation Council and European Society of Intensive Care Medicine 2015 guidelines for post-resuscitation care

Return of spontaneous circulation and comatose

Immediate treatment

Airway and breathing

- Maintain SpO₂ 94 – 98%
- Insert advanced airway
- Waveform capnography
- Ventilate lungs to normocapnia

Circulation

- 12-lead ECG
- Obtain reliable intravenous access
- Aim for SBP > 100 mmHg
- Fluid (crystalloid) – restore normovolaemia
- Intra-arterial blood pressure monitoring
- Consider vasopressor/ inotrope to maintain SBP

Control temperature

- Constant temperature 32°C – 36°C
- Sedation; control shivering

Diagnosis

Likely cardiac cause?

NO

YES

12-lead ECG ST elevation?

YES

NO

Coronary angiography ± PCI

Consider Coronary angiography ± PCI

Consider CT brain and/or CTPA

Cause for cardiac arrest identified?

NO

YES

Treat non-cardiac cause of cardiac arrest

Admit to Intensive Care Unit

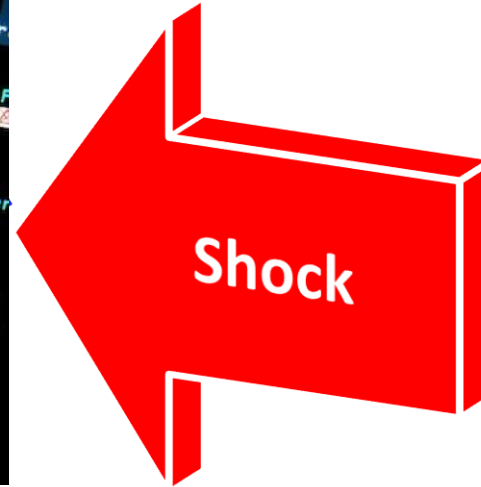
Optimising recovery

ICU management

- Temperature control: constant temperature 32°C – 36°C for ≥ 24h; prevent fever for at least 72 h
- Maintain normoxia and normocapnia; protective ventilation
- Optimise haemodynamics (MAP, lactate, ScvO₂, CO/CI, urine output)
- Echocardiography
- Maintain normoglycaemia
- Diagnose/treat seizures (EEG, sedation, anticonvulsants)
- Delay prognostication for at least 72 h

Secondary prevention
e.g. ICD, screen for inherited disorders,
risk factor management

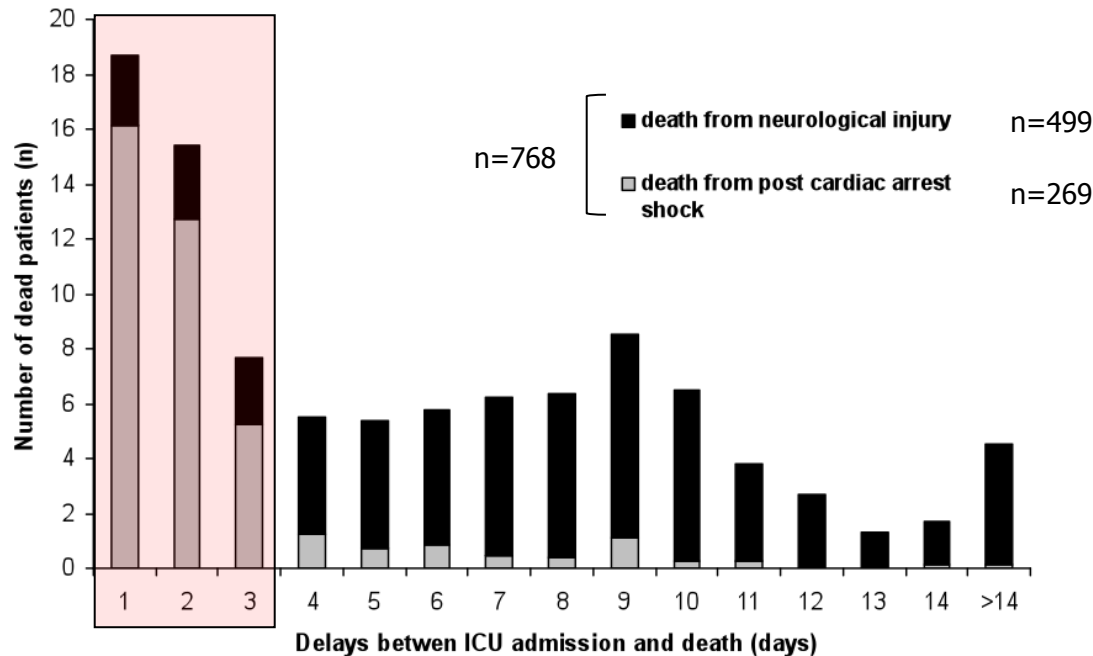
Follow-up and
rehabilitation

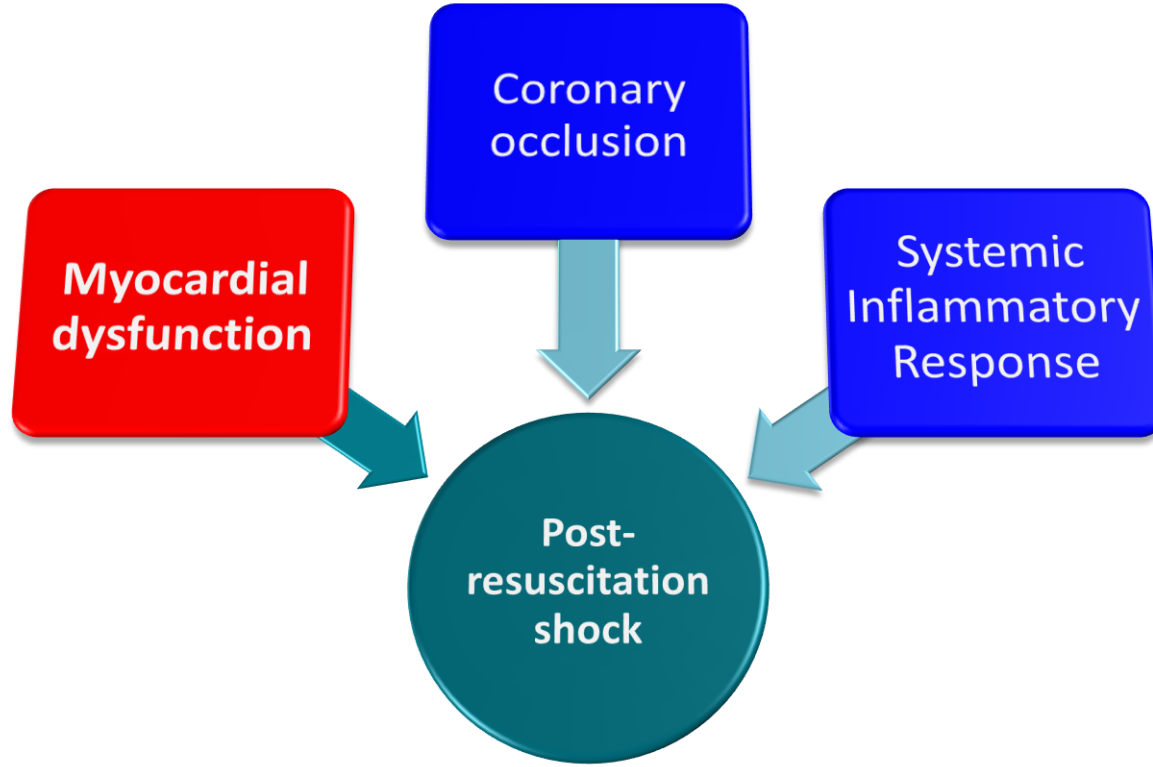


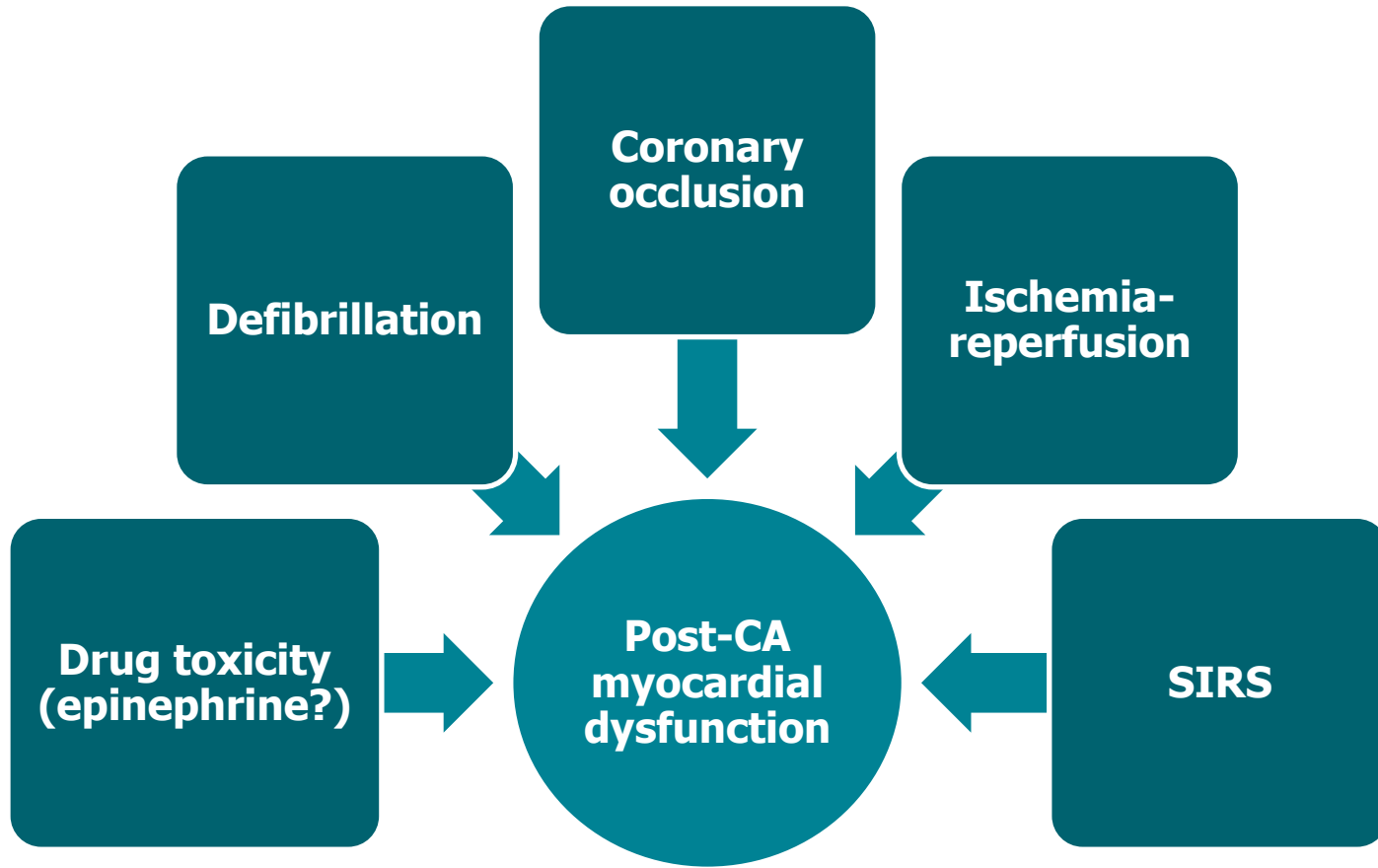
ICU mortality after cardiac arrest: the relative contribution of shock and brain injury in a large cohort

Lemiale V, Dumas F, Mongardon N, Giovanetti O, Charpentier J, hiche JD, Carli P, Mira JP, Nolan J, Cariou A. Intensive Care Med 2013

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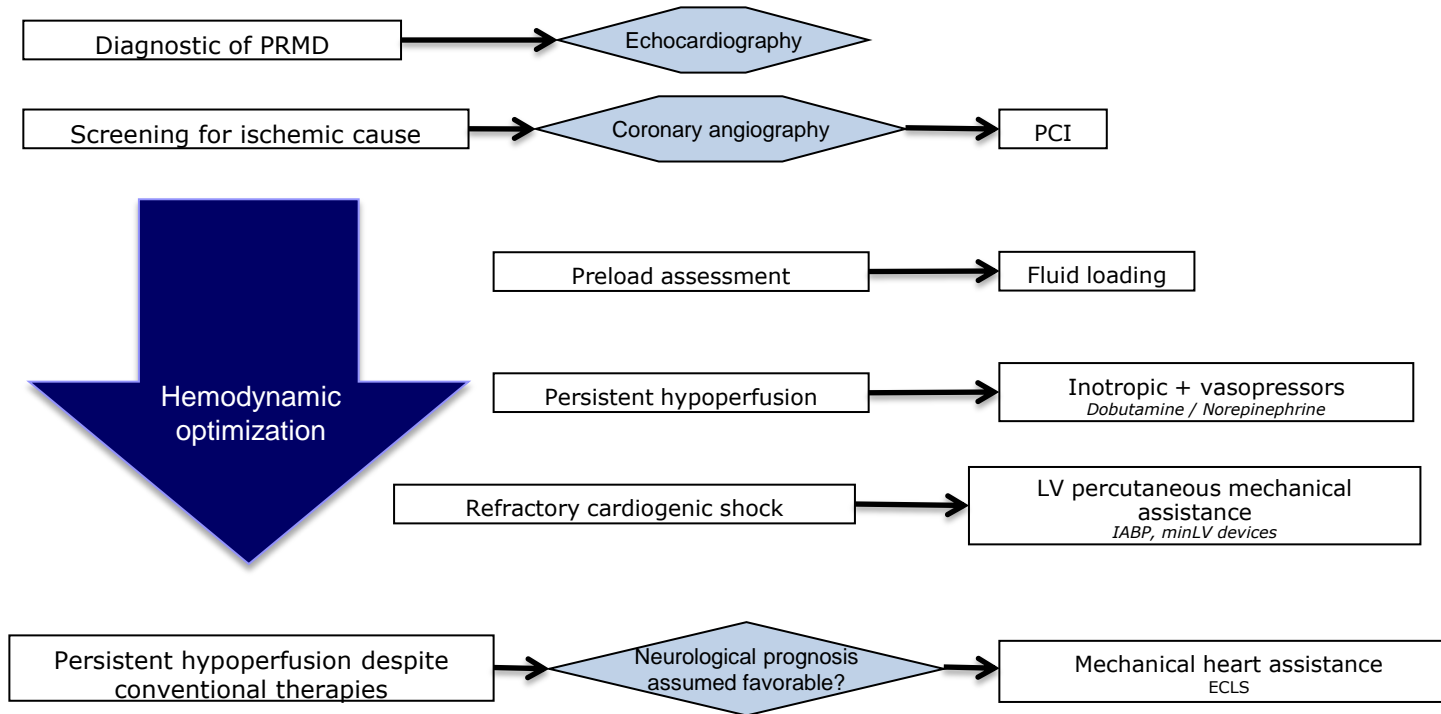




Post-cardiac arrest shock

Bougouin W & Cariou A. Curr Opin Crit Care 2013

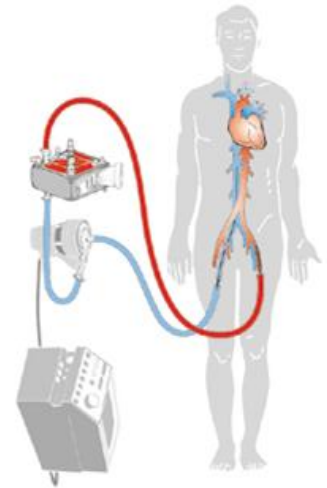
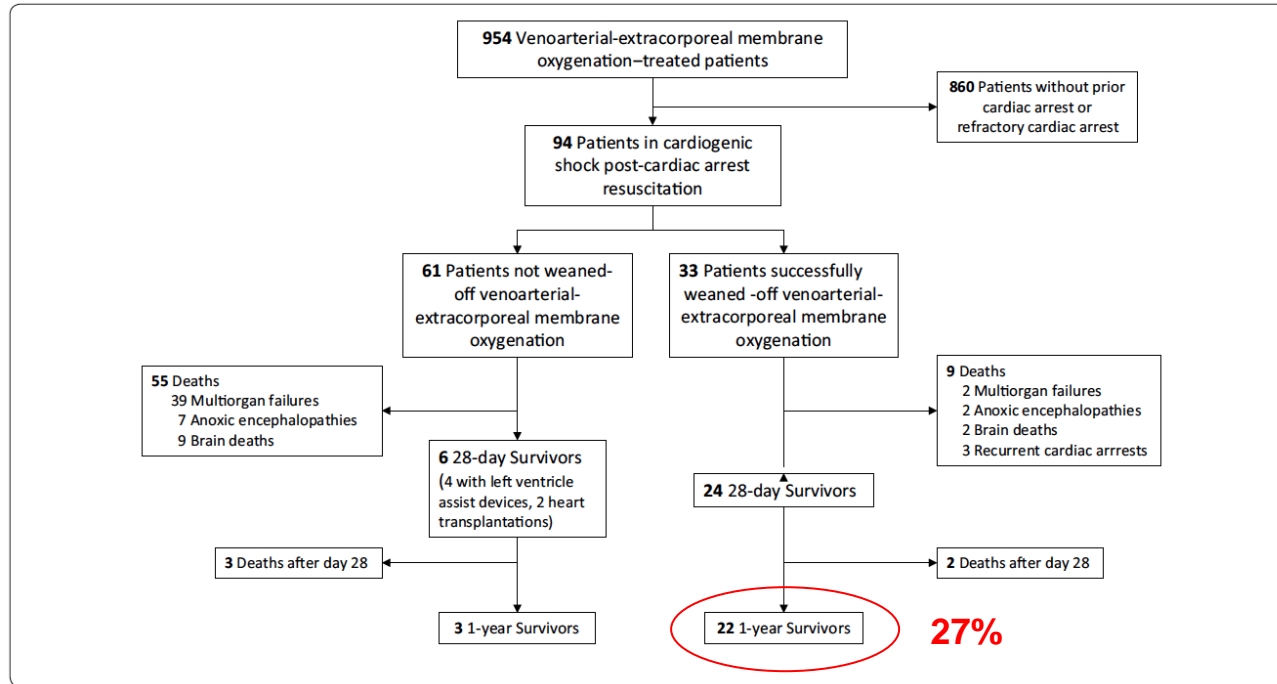
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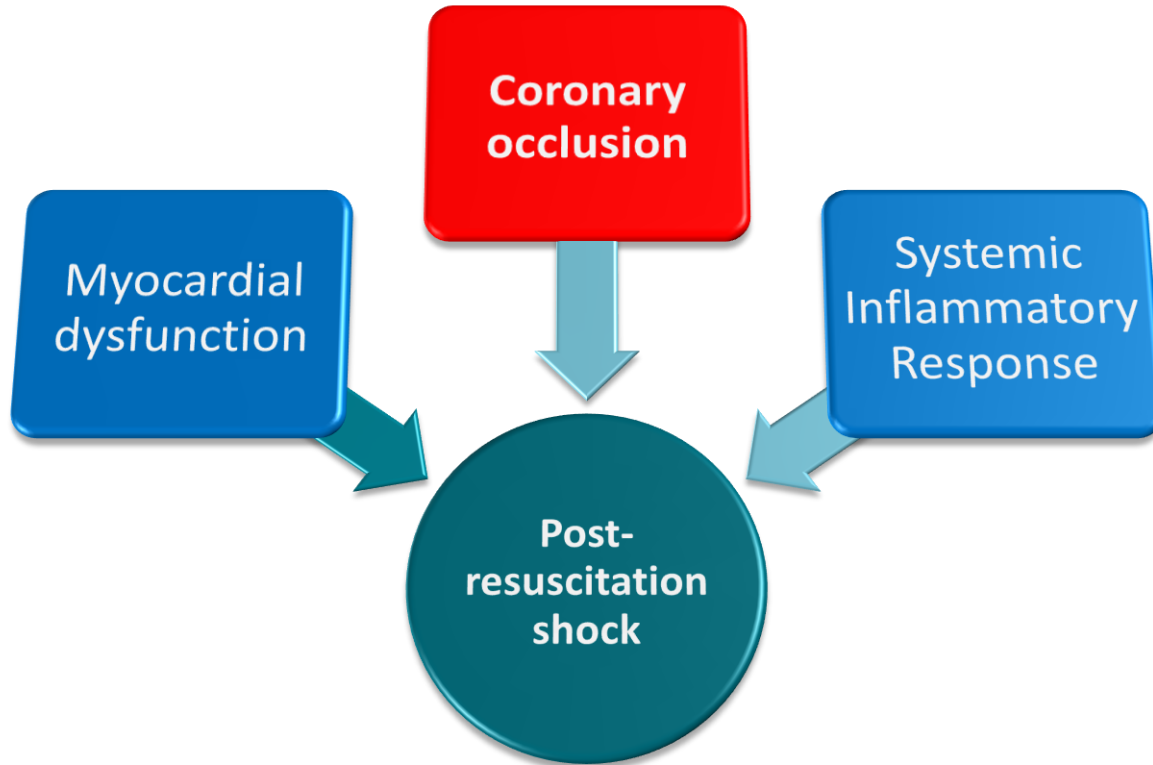


Venoarterial extracorporeal membrane oxygenation for refractory cardiogenic shock post-cardiac arrest

Intensive Care Med (2016) 42:1999–2007

Marc Pineton de Chambrun^{1,2}, Nicolas Bréchet^{1,2}, Guillaume Lebreton³, Matthieu Schmidt^{1,2}, Guillaume Hekimian^{1,2}, Pierre Demondion³, Jean-Louis Trouillet^{1,2}, Pascal Leprince³, Jean Chastre^{1,2}, Alain Combes^{1,2} and Charles-Edouard Luyt^{1,2*}





Mild therapeutic hypothermia in patients after out-of-hospital cardiac arrest due to acute ST-segment elevation myocardial infarction undergoing immediate percutaneous coronary intervention*

Crit Care Med 2008 Vol. 36, No. 6

Sebastian Wolfrum, MD; Christian Pierau; Peter W. Radke, MD; Heribert Schunkert, MD; Volkhard Kurowski, MD

Acute Ischemic Heart Disease

(Am Heart J 2009;157:312-8.)

Acute coronary angiographic findings in survivors of out-of-hospital cardiac arrest

Zacharias Alexandros Anyfantakis, MD,^{a,b} Gabriel Baron, MSc,^c Pierre Aubry, MD,^a Dominique Himbert, MD,^a Laurent J. Feldman, MD, PhD,^a Jean-Michel Juliard, MD,^a Agnès Ricard-Hibon, MD,^d Alexis Burnod, MD,^d Dennis V. Cokkinos, MD,^b and Philippe Gabriel Steg, MD^a *Paris and Clichy, France; and Athens, Greece*

Circulation March 20, 2007

Six-Month Outcome of Emergency Percutaneous Coronary Intervention in Resuscitated Patients After Cardiac Arrest Complicating ST-Elevation Myocardial Infarction

Philippe Garot, MD; Thierry Lefevre, MD; Hélène Eltchaninoff, MD, PhD; Marie-Claude Morice, MD; Fabienne Tamion, MD; Bernard Abry, MD; Pierre-François Lesault, MD; Jean-Yves Le Tarneac, MD; Claude Pougès, MD; Alain Margenet, MD; Mehran Monchi, MD; Ivan Laurent, MD; Pierre Dumas, MD; Jérôme Garot, MD, PhD; Yves Louvard, MD

Clinical paper

Resuscitation 85 (2014) 1245–1250

Post-resuscitation electrocardiograms, acute coronary findings and in-hospital prognosis of survivors of out-of-hospital cardiac arrest*



Julio Garcia-Tejada^{a,*}, Alfonso Jurado-Román^a, Jesús Rodríguez^b, Maite Velázquez^a, Felipe Hernández^a, Agustín Albarrán^a, Roberto Martín-Asenjo^b, Carolina Granda-Nistal^a, Raúl Coma^b, Juan Tascón^a



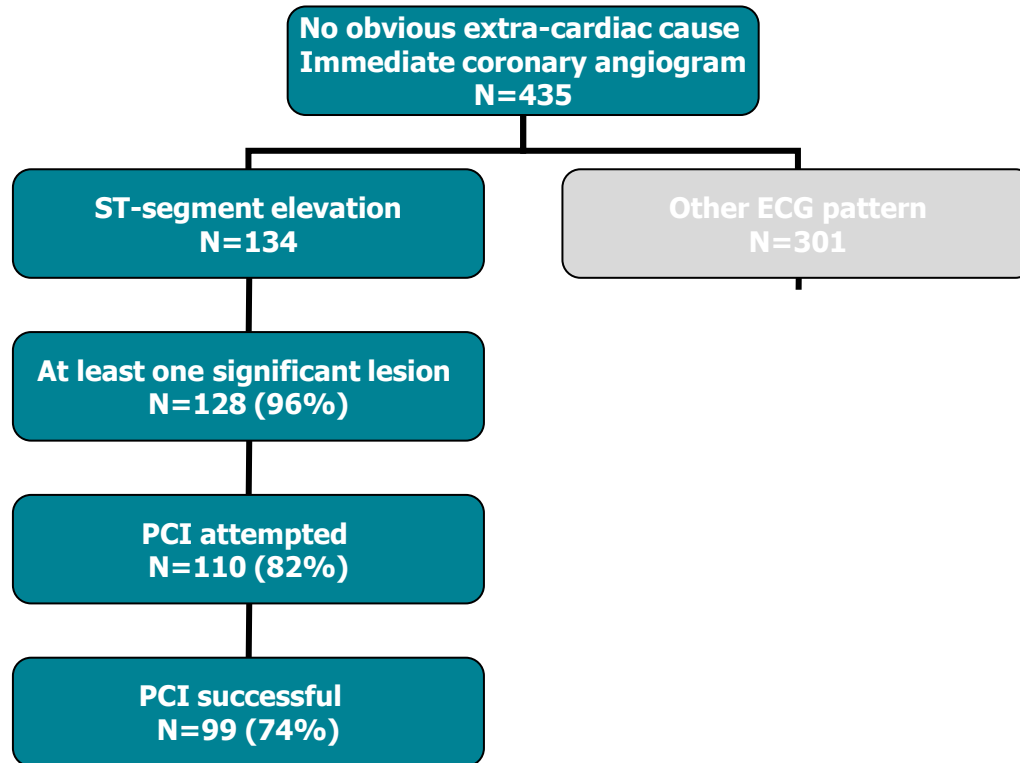
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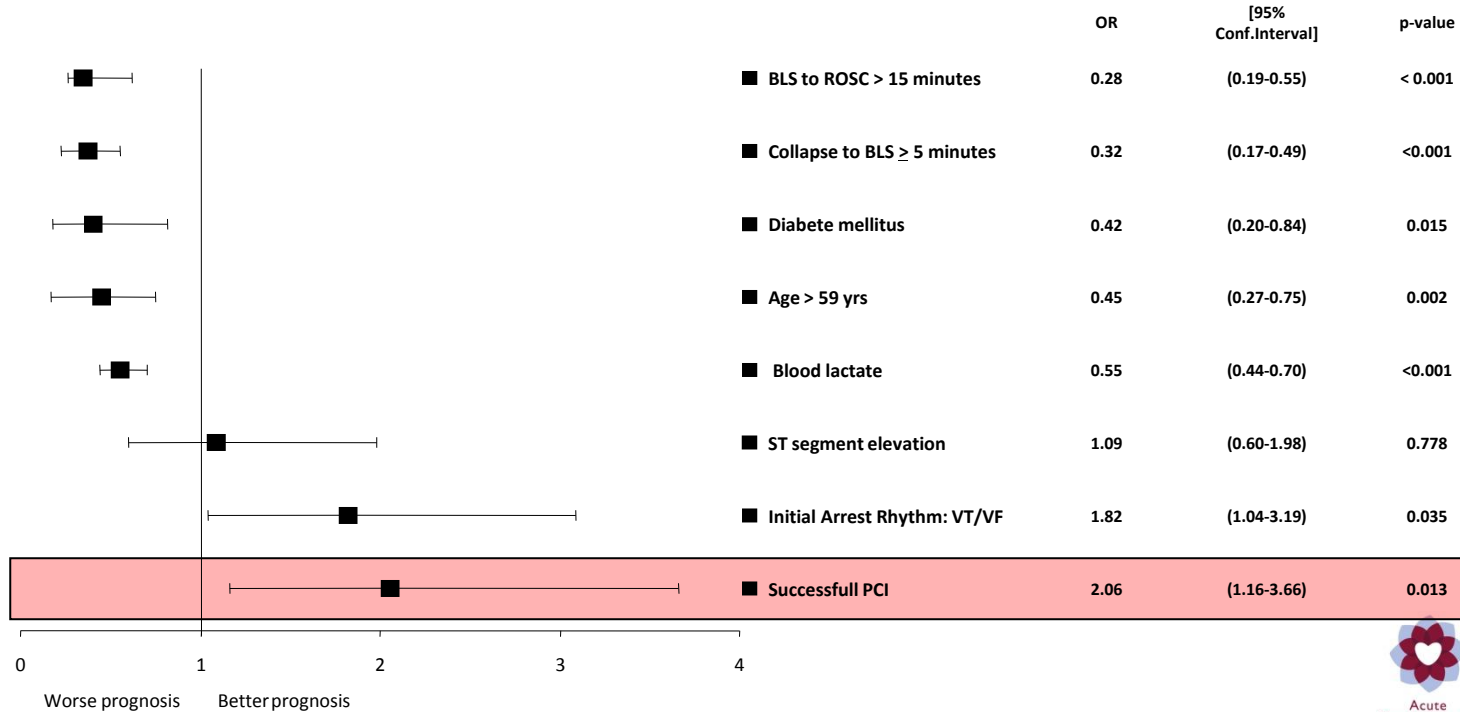
Should We Perform an Immediate Coronary Angiogram in All Survivors of OHCA With No Obvious Extra-Cardiac Cause? Insights from the PROCAT registry

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• **Should We Perform an Immediate Coronary Angiogram in All Survivors of OHCA With No Obvious Extra-Cardiac Cause? Insights from the PROCAT registry**

Multivariate analysis of early predictors of survival in OHCA pts without obvious extra-cardiac etiology





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Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Resuscitation

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



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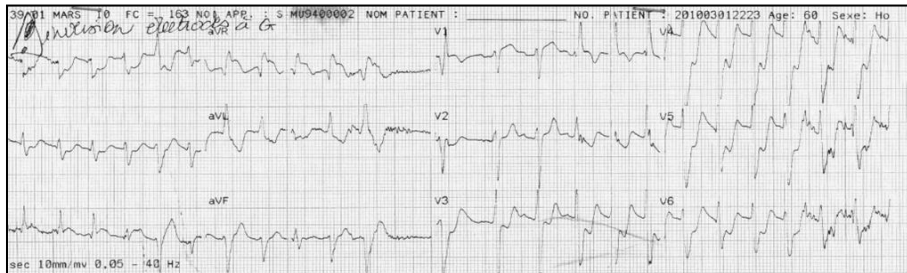
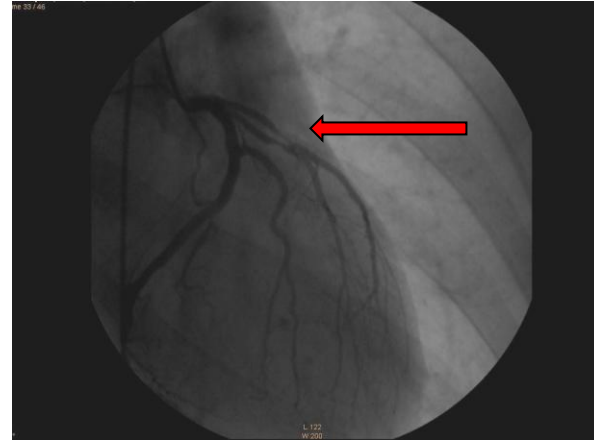
European Resuscitation Council Guidelines for Resuscitation 2015 Section 8. Initial management of acute coronary syndromes

Nikolaos I. Nikolaou^{a,*}, Hans-Richard Arntz^b, Abdelouahab Bellou^c, Farzin Beygui^d,
Leo L. Bossaert^e, Alain Cariou^f, Initial management of acute coronary syndromes
section Collaborator¹

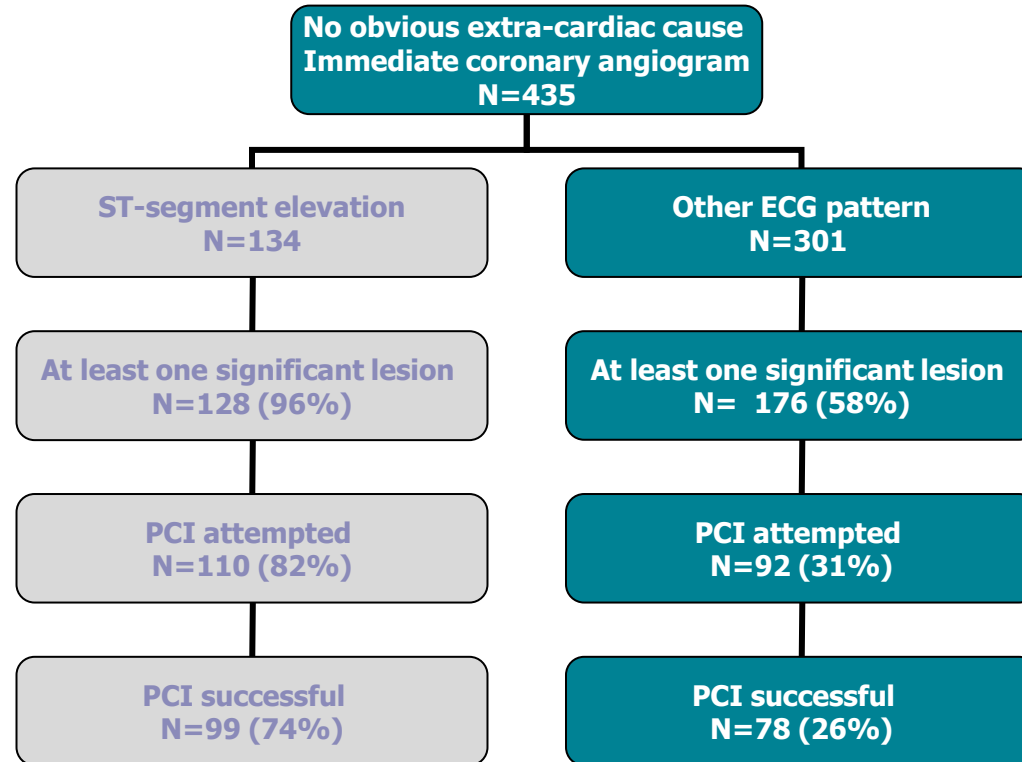
1. Based on the available data, emergent cardiac catheterisation lab evaluation (and immediate PCI if required) **should be performed** in selected adult patients with ROSC after OHCA of suspected cardiac origin with ST segment elevation on ECG.

Paul A, 67y

- **Hypertension, smoking**
- **Resuscitated 1 hour ago from an OHCA:**
 - No flow: 4 minutes
 - Low flow: 12 minutes
 - VF (3 DC shocks)
 - 2 mg epinephrine
- **ECG post ROSC :**

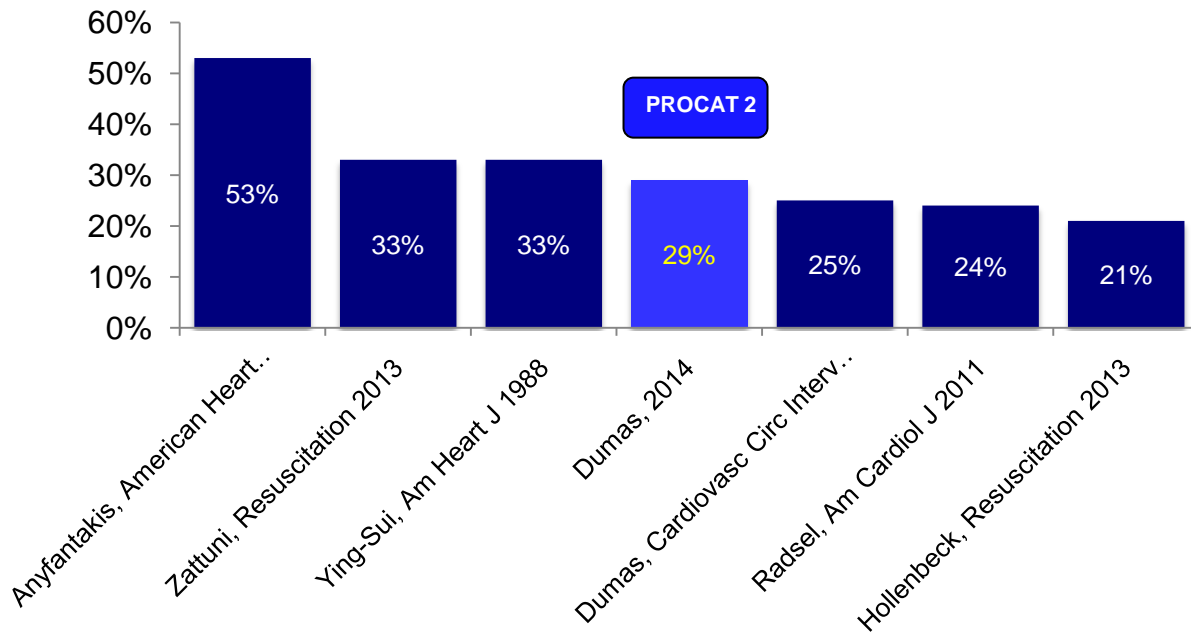


Should We Perform an Immediate Coronary Angiogram in All Survivors of OHCA With No Obvious Extra-Cardiac Cause? Insights from the PROCAT registry

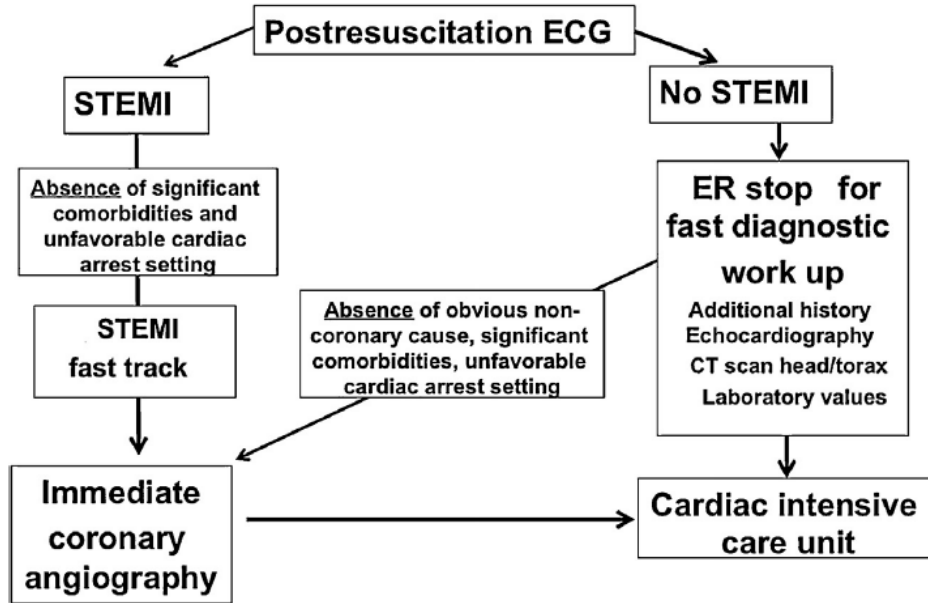


Is emergent PCI associated with a clinical benefit in post-cardiac arrest patients without ST segment elevation pattern? Insights from the Parisian registry (PROCAT II)

Dumas F, Bougouin W, Geri G, Lamhaut L, Rosencher J, Pène F, Chiche JD, Varenne O, Carli P, Jouven X, Mira JP, Spaulding C, Cariou A (JACC Cardiovasc Interv 2016)



Is delayed PCI equivalent to immediate PCI after CA?



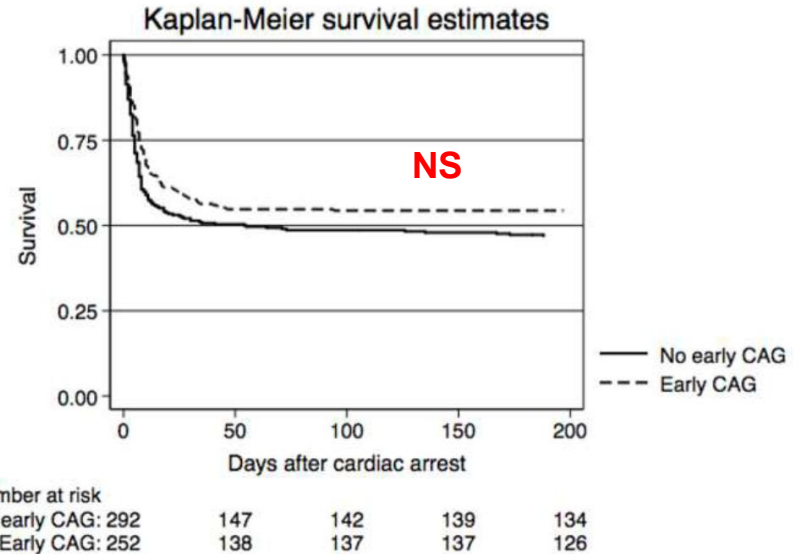
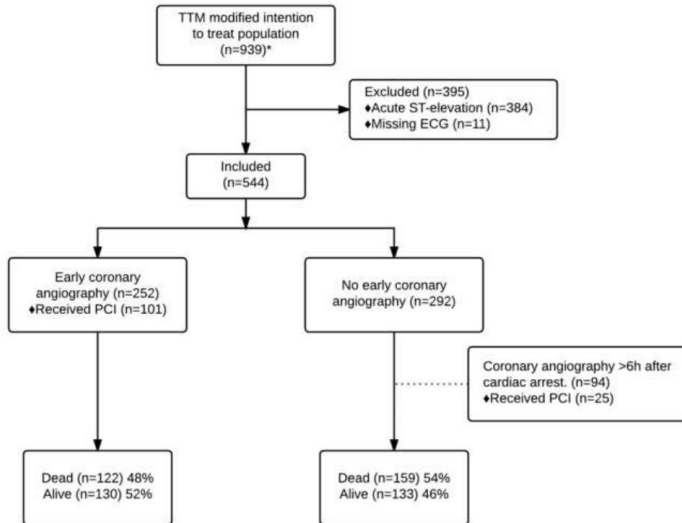
Is early PCI associated with a clinical benefit in post-cardiac arrest patients without STEMI pattern? Insights from the Parisian registry (PROCAT II)

Multivariate analysis of predictors for good outcome in OHCA pts without obvious extra-cardiac etiology

	Odds Ratio	[95% Conf. interval]	p-value
Age (year)	0.97	[0.95-0.99]	0.002
Male gender	1.20	[0.69-2.09]	0.53
Diabetes	1.64	[0.89-3.0]	0.11
Hypertension	1.04	[0.63-1.72]	0.87
Smoking	1.18	[0.73-1.91]	0.50
Public location	1.25	[0.77-2.04]	0.37
Witnessed CA	3.21	[0.81-12.65]	0.10
Bystander CPR	1.37	[0.85-2.20]	0.19
Initial shockable rhythm	3.38	[1.94-5.87]	<0.001
Resuscitation length < 20 min	3.13	[1.93-5.07]	<0.001
Epinephrine < 2 mg during CPR	0.27	[0.16-0.46]	<0.001
Targeted Temperature Management	0.93	[0.41-2.07]	0.85
Post cardiac arrest shock	0.57	[0.36-0.92]	0.02
PCI	1.86	[1.13-3.08]	0.016

Survival in patients without acute ST-elevation after CA and association to early coronary angiography - a post hoc analysis from the TTM trial

Dankiewicz J et al. *Intensive Care Med* 2015





Direct or Subacute Coronary Angiography for Out-of-hospital Cardiac Arrest (DISCO)

This study is currently recruiting participants. (see [Contacts and Locations](#))

Verified January 2015 by Uppsala University

Sponsor:
Uppsala University

Collaborators:
Stockholm South General Hospital
Skåne University Hospital

Information provided by (Responsible Party):
Uppsala University

ClinicalTrials.gov Identifier:
NCT02309151

First received: November 17, 2014
 Last updated: January 7, 2015
 Last verified: January 2015
[History of Changes](#)



DISCO Study

[How to Read a Study Record](#)

► **Purpose**

The overall aim of this prospective, randomized pilot study is to investigate whether acute coronary angiography (within 120 minutes) with a predefined strategy for revascularization, is safe to implement in patients with out of hospital cardiac arrest. The primary question at issue is whether early angiography (within 120 minutes) with a predefined strategy for revascularization with percutaneous coronary intervention (PCI) is safe to carry out in this group of patients. The patients randomized to acute coronary angiography will be compared with a control group who will be treated according to standard practice with coronary angiography with possible subsequent intervention according to the current routine, which usually does not occur within the first three days after cardiac arrest.

Criteria

Inclusion Criteria:

- Witnessed out of hospital cardiac arrest
- Regained circulation (ROSC)
- Coronary angiography is expected to be completed within 120 minutes from first medical contact. This medical contact is included by ambulance or at the latest at the emergency room

Exclusion Criteria:

- Patient age <18 years
- Obvious extracardiac genesis of cardiac arrest such as trauma, hemorrhagic shock, and / or asphyxia (eg drowning, suffocation, hanging, exposure to fire smoke)
- Terminally ill patients with a life expectancy of less than 1 year
- Patients with ST-elevation on the first ECG will not be randomized in the study but observed and followed in the study.
- Known pregnancy



Contents lists available at [ScienceDirect](#)

Resuscitation

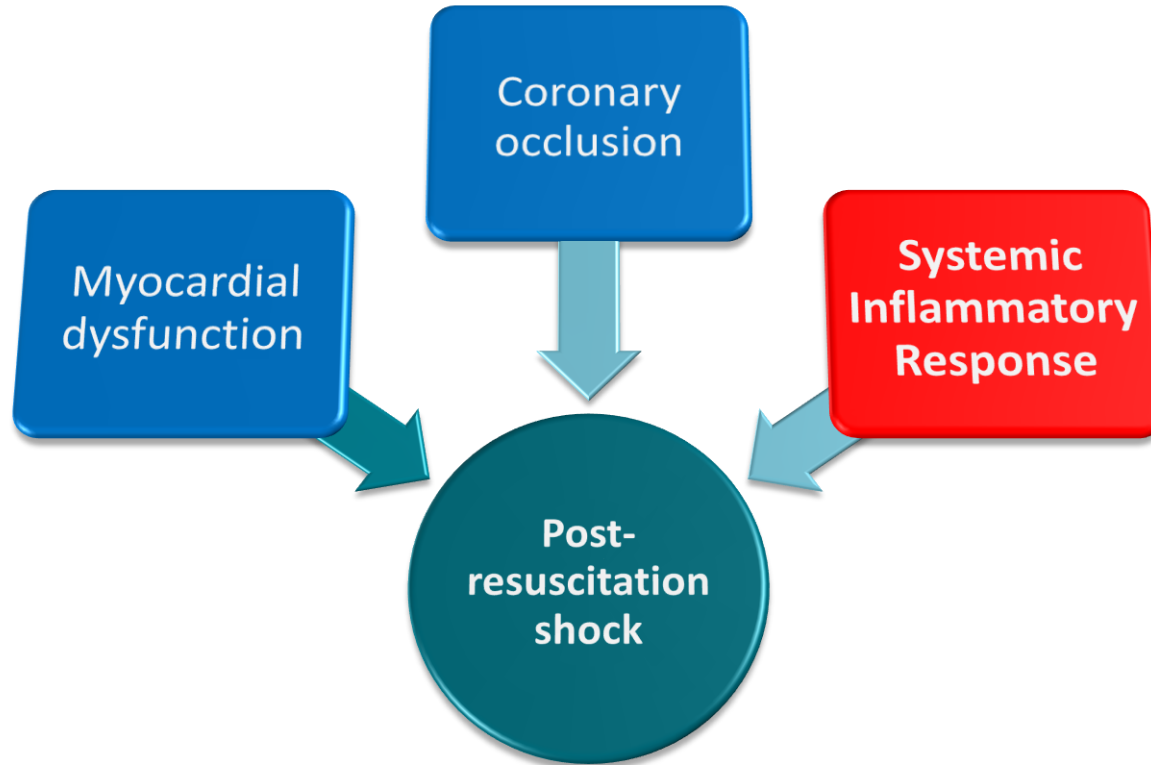
journal homepage: www.elsevier.com/locate/resuscitation



European Resuscitation Council Guidelines for Resuscitation 2015 Section 8. Initial management of acute coronary syndromes

Nikolaos I. Nikolaou^{a,*}, Hans-Richard Arntz^b, Abdelouahab Bellou^c, Farzin Beygui^d,
Leo L. Bossaert^e, Alain Cariou^f, Initial management of acute coronary syndromes
section Collaborator¹

1. Based on the available data, emergent cardiac catheterisation lab evaluation (and immediate PCI if required) **should be performed** in selected adult patients with ROSC after OHCA of suspected cardiac origin with ST segment elevation on ECG.
2. In other patients, it is **reasonable to discuss** an emergent cardiac catheterisation lab evaluation after ROSC in patients with the highest risk of coronary cause of CA.



Post-resuscitation disease after cardiac arrest: a sepsis-like syndrome?

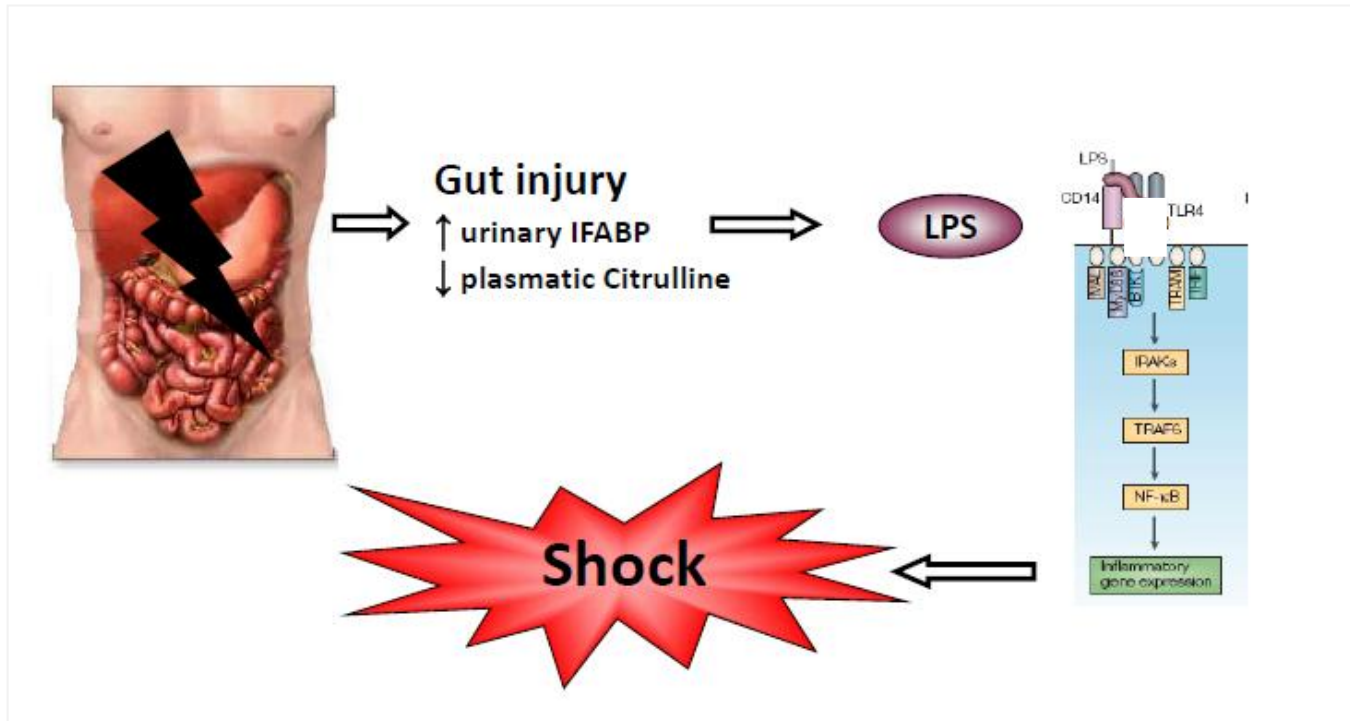
Adrie C, Laurent I, Monchi M, Cariou A, Dhainaut JF, Spaulding C.

Current Opinion in Crit Care 2004

1. **Ischemia and reperfusion syndrome**
2. **Inflammatory response**
3. **Coagulopathy**
4. **Circulatory failure**
5. **Adrenal dysfunction**

Endotoxemia is correlated with gut injury after cardiac arrest and contributes to post-resuscitation shock

Grimaldi D et al. Resuscitation 2012



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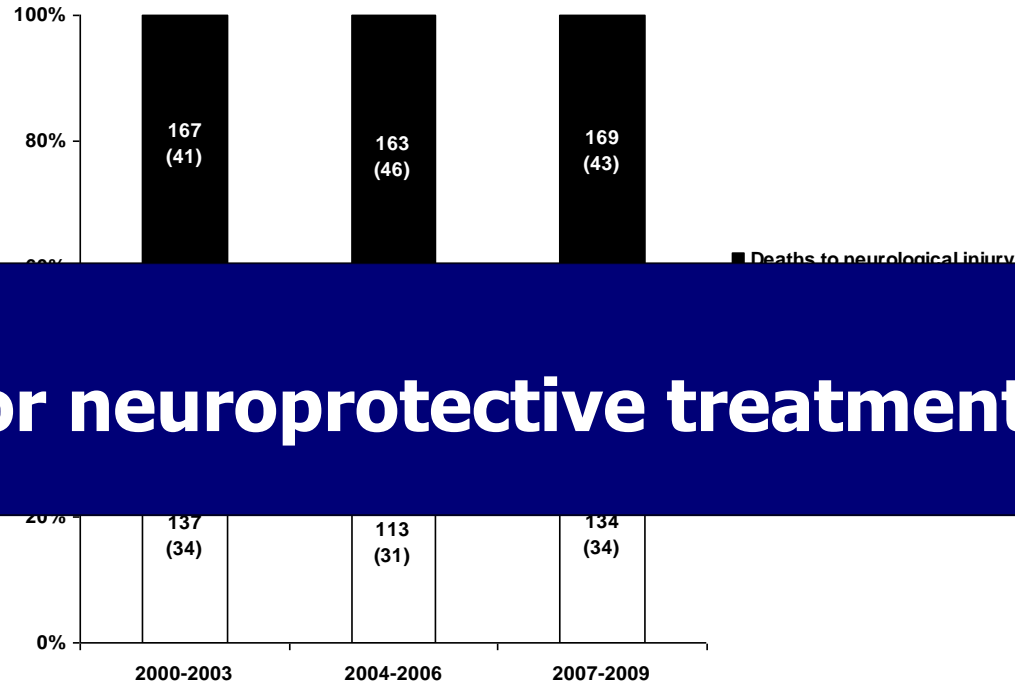


ICU mortality after cardiac arrest: the relative contribution of shock and brain injury in a large cohort

Lemiale V, Dumas F, Mongardon N, Giovanetti O, Charpentier J, Chiche JD, Carli P, Mira JP, Nolan J, Cariou A

Intensive Care Med 2013

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Need for neuroprotective treatments...

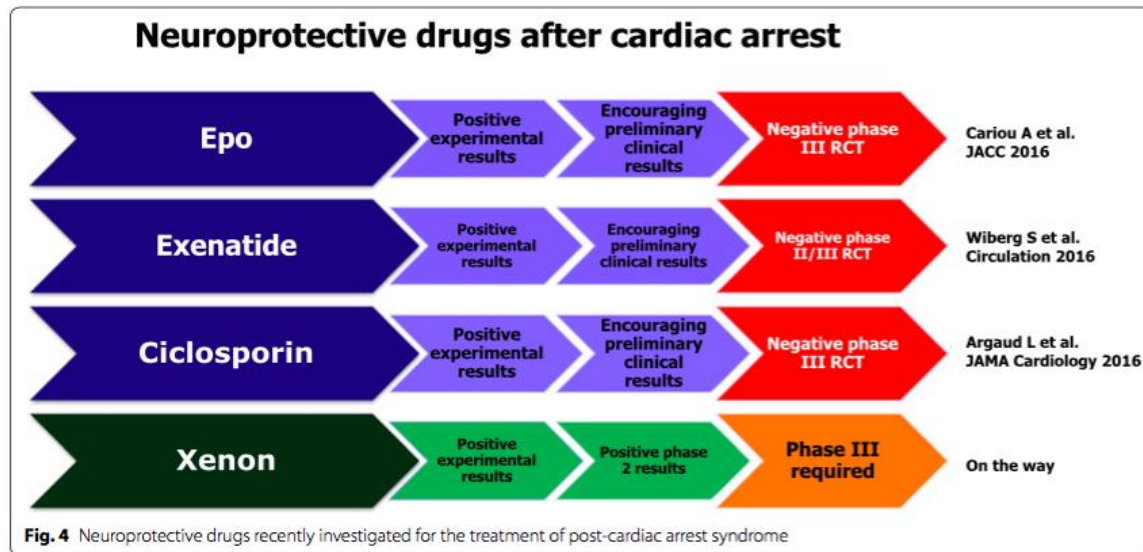
Intensive care medicine research agenda on cardiac arrest

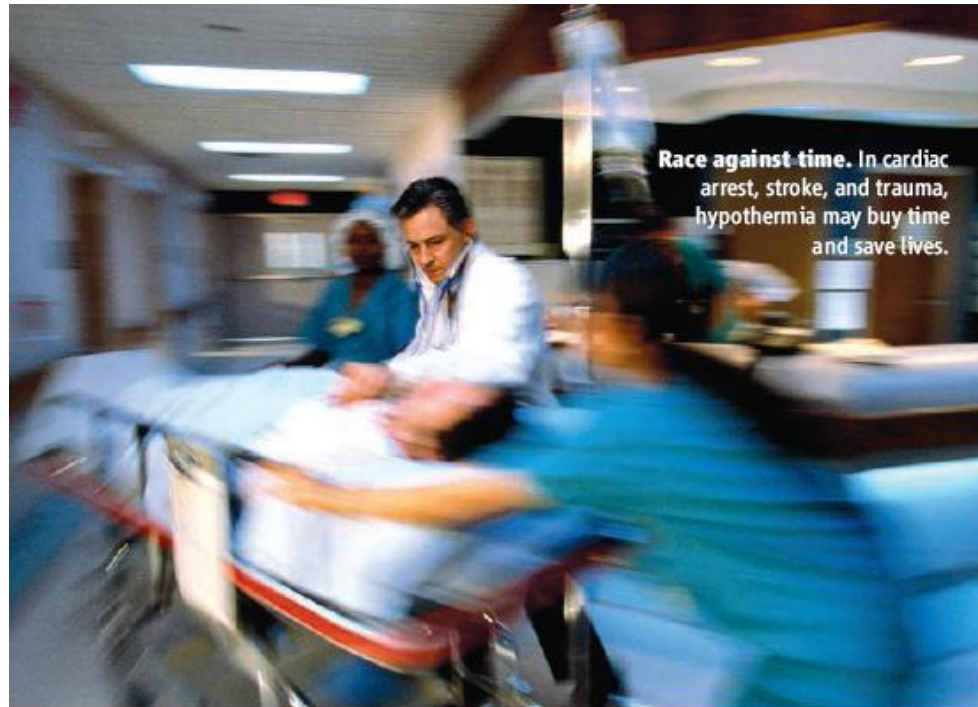


Intensive Care Med
DOI 10.1007/s00134-017-4739-7

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Jerry P. Nolan^{1,2*} , Robert A. Berg^{3,4}, Stephen Bernard⁵, Bentley J. Bobrow⁶, Clifton W. Callaway⁷, Tobias Cronberg⁸, Rudolph W. Koster⁹, Peter J. Kudenchuk¹⁰, Graham Nichol¹¹, Gavin D. Perkins¹², Tom D. Rea¹³, Claudio Sandroni¹⁴, Jasmeet Soar¹⁵, Kjetil Sunde^{16,17} and Alain Cariou¹⁸





Race against time. In cardiac arrest, stroke, and trauma, hypothermia may buy time and save lives.

MEDICINE

SCIENCE VOL 317 10 AUGUST 2007

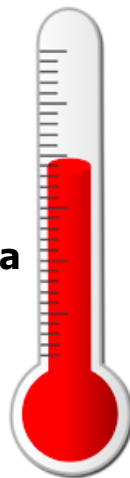
The Big Chill

Lowering the body's temperature improves the chances of surviving a cardiac arrest and other types of trauma; but as cold therapy expands, researchers are struggling to understand why and for whom it works

Targeted temperature management after cardiac arrest

WHAT LEVEL?

33° C: the dogma



Targeted temperature management after cardiac arrest

WHAT LEVEL?

33° C: the dogma

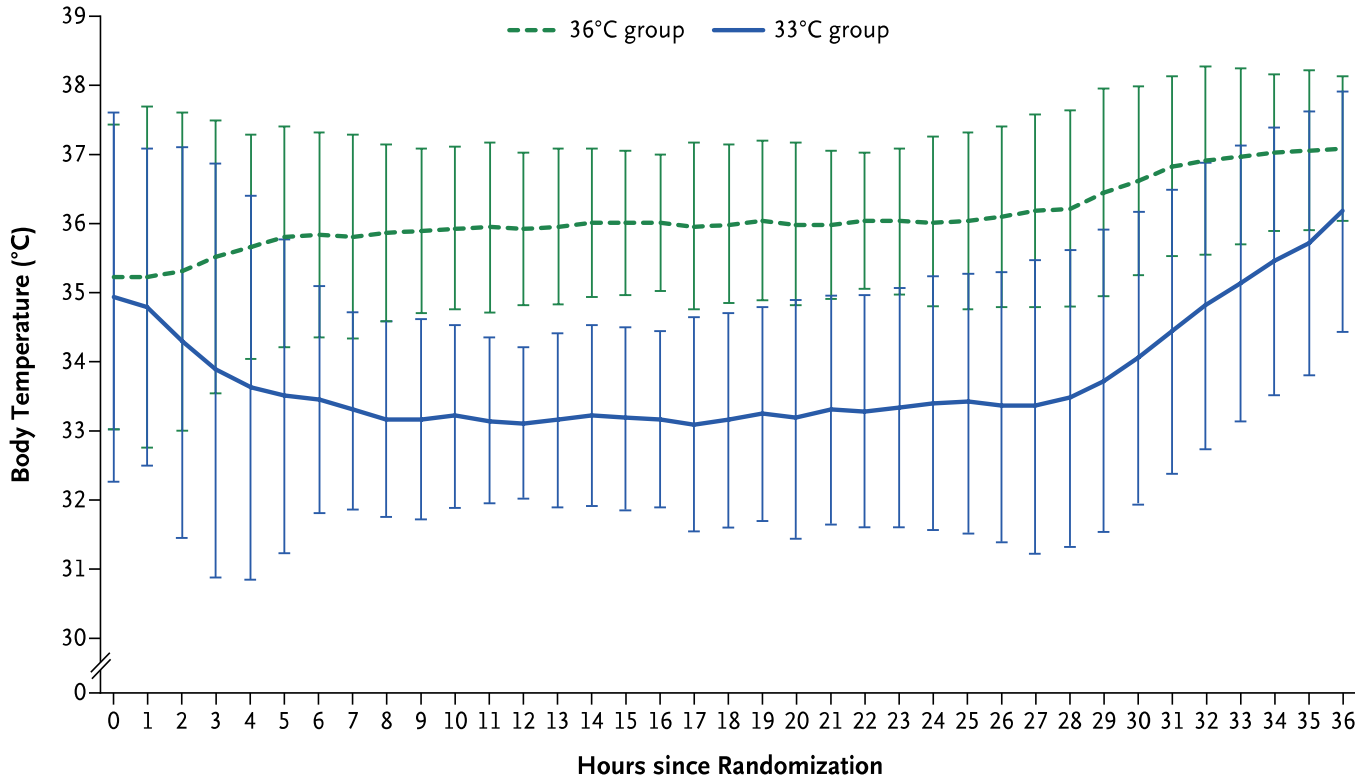


36° C: the future?



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

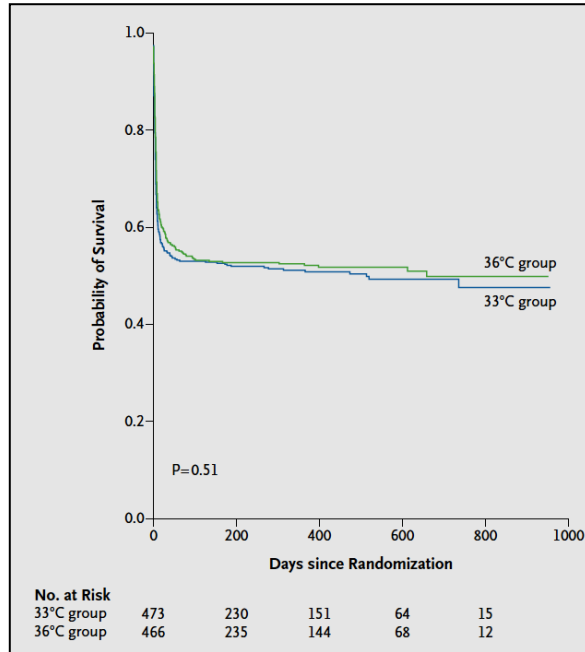
Nielsen N. NEJM 2013





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

Nielsen N. NEJM 2013

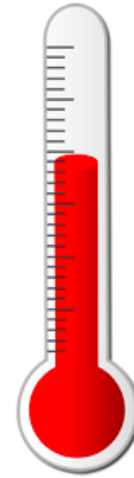


Variable	33°C Group	36°C Group
CPC at follow-up†		
Total no. of patients	469	464
Category — no. (%)		
1	195 (42)	183 (39)
2	23 (5)	39 (8)
3	17 (4)	20 (4)
4	6 (1)	2 (0.5)
5	228 (49)	220 (47)
P value for trend	0.85	



2015 Guidelines: **Temperature management after cardiac arrest?**

ILCOR and ERC/ESICM:
Cooling is recommended +++
Target temperature between 32-36 ° C



Predicting neurological outcome

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Neuroprognostication after cardiac arrest

- **Important:**
 - To inform patient's relatives
 - To avoid futile treatments in patients with no chance of recovery
- **High specificity and precision essential**
 - Lowest possible false positive rate (FPR) with narrow CIs



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Resuscitation

journal homepage: www.elsevier.com/locate/resuscitationWE
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Review article

Resuscitation 84 (2013) 1324–1338



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Contents lists available at ScienceDirect

journal ho

Total 87 studies
5231 patients

scitation



Review article

Predictors of poor neurological outcome in adult comatose survivors of cardiac arrest: A systematic review and meta-analysis.

Part 2: Patients treated with therapeutic hypothermia[☆]

Claudio Sandroni^{a,*}, Fabio Cavallaro^a, Clifton W. Callaway^b, Sonia D'Arrigo^a, Tommaso Sanna^c, Michael A. Kuiper^d, Matteo Biancone^a, Giacomo Della Marca^e, Alessio Farcomeni^f, Jerry P. Nolan^g

^a Department of Anaesthesiology and Intensive Care, Catholic University School of Medicine, Rome, Italy

^b Department of Emergency Medicine, University of Pittsburgh, United States

^c Department of Cardiovascular Sciences, Catholic University School of Medicine, Rome, Italy

^d Department of Intensive Care, Medical Center Leeuwarden, Leeuwarden, The Netherlands

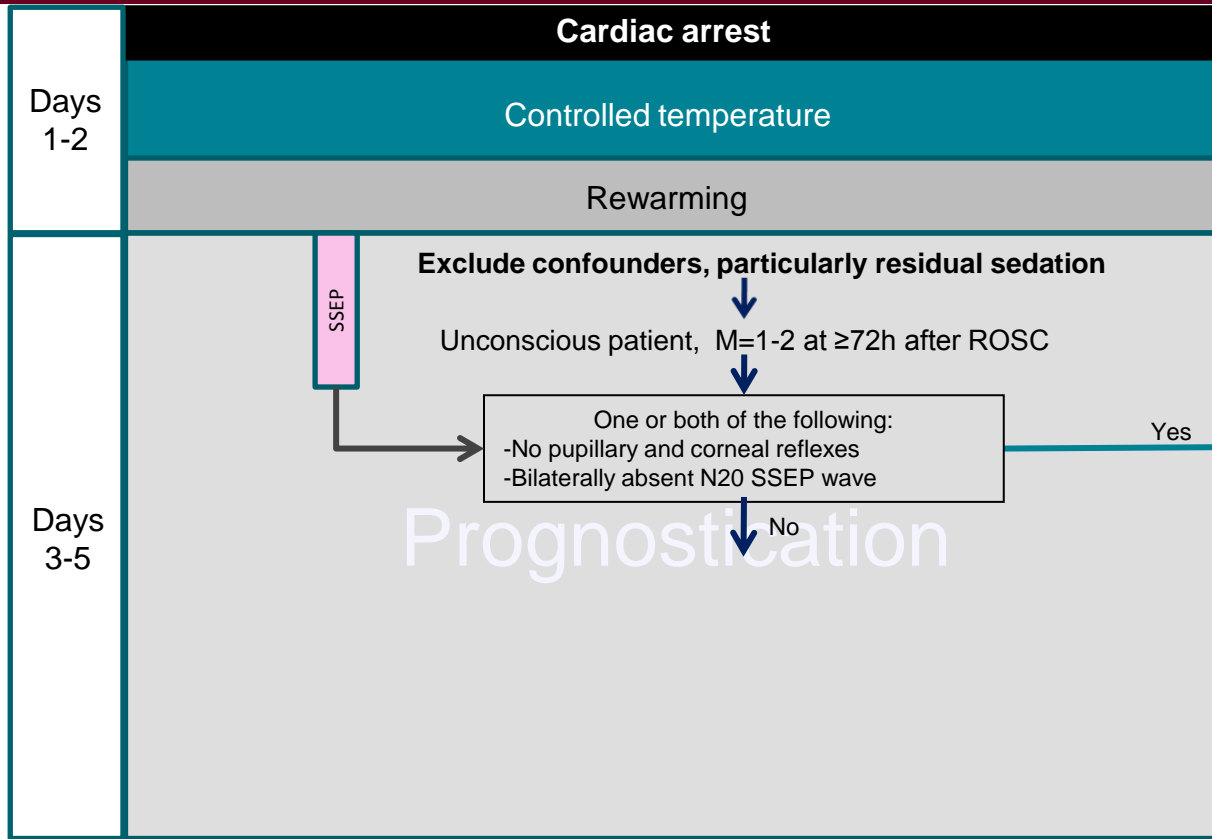
^e Department of Neurology, Catholic University School of Medicine, Rome, Italy

^f Department of Public Health and Infectious Diseases, Statistics Section, Sapienza University of Rome, Italy

^g Department of Anaesthesia and Intensive Care Medicine, Royal United Hospital, Bath, UK



CrossMark

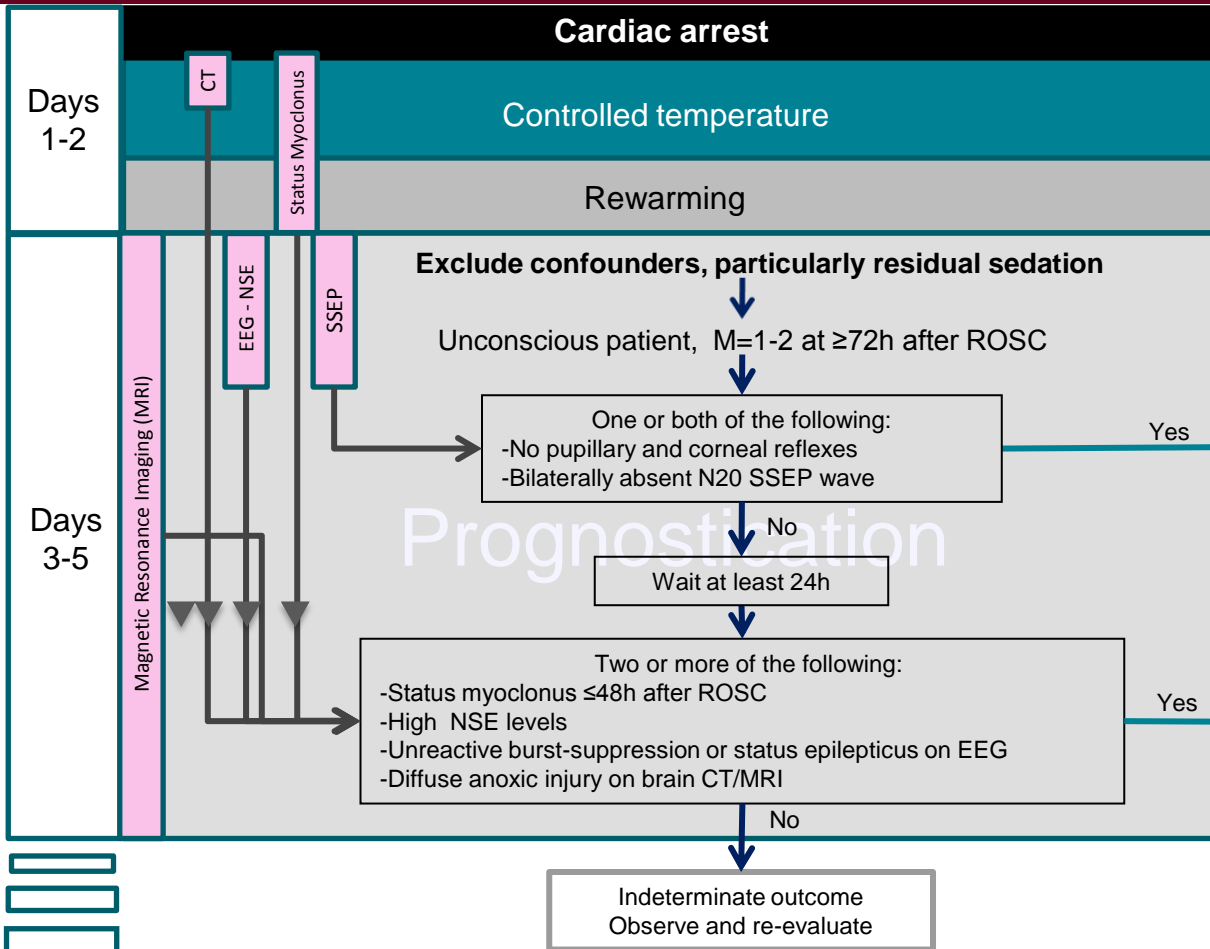


SSEP

Yes

Poor outcome
very likely
(FPR <5%, narrow
95%CIs)





2015 ERC-ESICM Guidelines for management of post-cardiac arrest patients

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ICU management

- Temperature control: constant temperature 32°C – 36°C for ≥ 24 h; prevent fever for at least 72 h
- Maintain normoxia and normocapnia; protective ventilation
- Optimise haemodynamics (MAP, lactate, ScvO₂, CO/CI, urine output)
- Echocardiography
- Maintain normoglycaemia
- Diagnose/treat seizures (EEG, sedation, anticonvulsants)
- Delay prognostication for at least 72 h