Con il patrocinio di

REGIONE LIGURIA

IRC Italian Resuscitation Council

CONGRESSO NAZIONALE IRC 2017

13 · 14 OTTOBRE

DALL'EVIDENZA **AI TRATTAMENTI FUTURI**

CENTRO CONGRESSI MAGAZZINI DEL COTONE

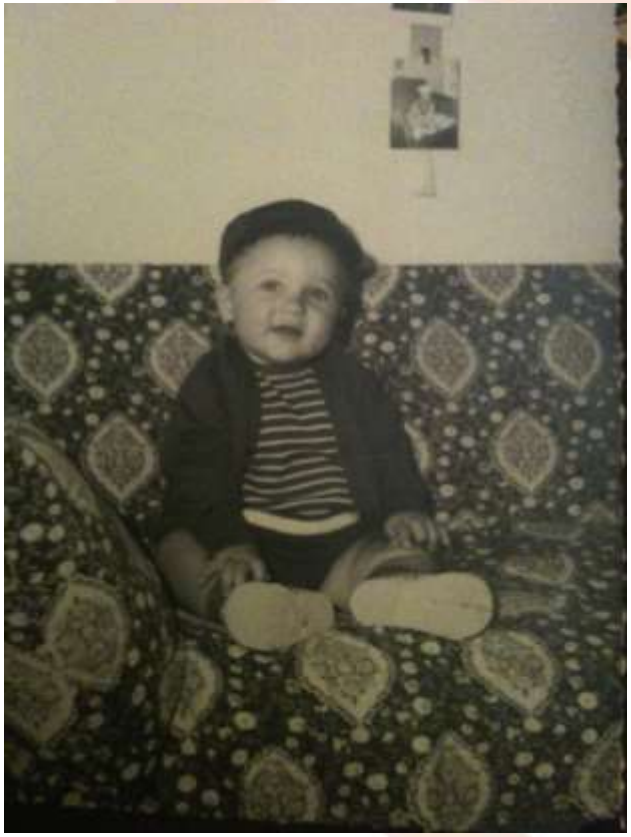
PORTO ANTICO GENOVA

Post Rianimazione

BUNDLES DI TRATTAMENTO NEL BAMBINO

Genova 14 Ottobre 2017

Conflitti d'Interesse (CI)



CI

8 Posti Letto
500 ricoveri x Anno
NIMV –HFOV - NO
152 codici rossi/anno
15.000 accessi vs 100.000

CI

Formazione
Simulazione

13 E 14 OTTOBRE

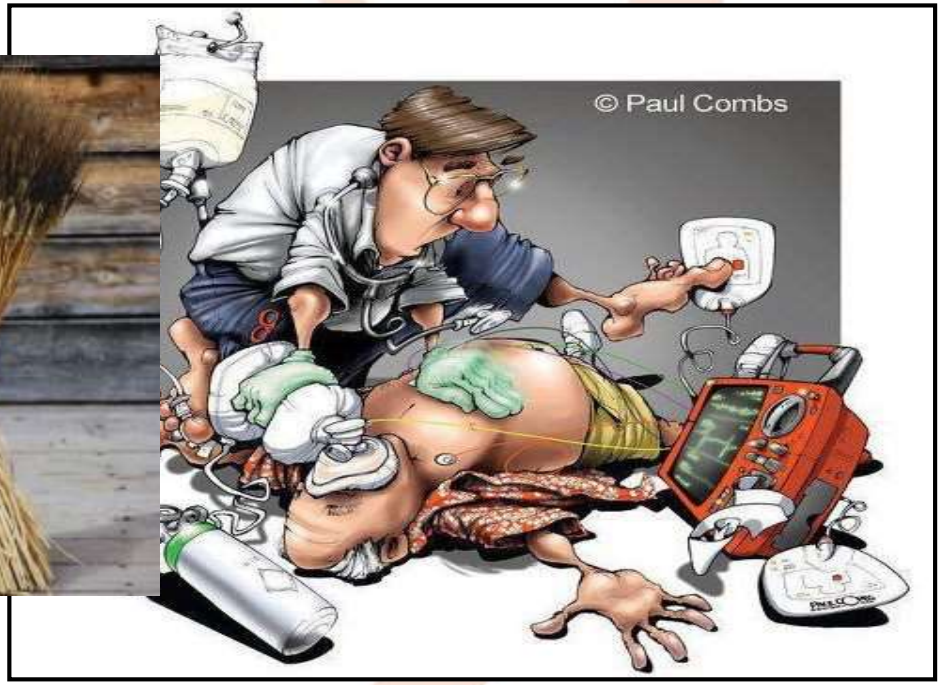
CENTRO CONGRESSI MAGAZZINI DEL COTONE
PORTO ANTICO GENOVA

CONGRESSO NAZIONALE IRC
2017

IRC | Italian Resuscitation Council

Post Rianimazione

BUNDLES DI TRATTAMENTO NEL BAMBINO



Pre-Arrest

Cardiac Arrest

CPR

Post-Arrest stabilization

No Flow

Low Flow

Low, Normal or High Flow

•PROTECTION

PRESERVATION

RESUSCITATION

•RESUSCITATION /REGENERATION

- Rapid Recognition
- Call for Help
- Response Team
- Oxygen/Ventilation

- Prompt CC
- Defibrillate if VF

- Push hard, Push Fast
- Minimize interruption
- Full recoil
- Assist ventilation?
  - Vasopressors?
  - Cooling?

- Temperature control
- Blood pressure
- Oxygen titration
- ? Cardiac Catheterization (PCI)
- Glucose
- Ventilation (CO_2)
- Seizure Control
- Goal Directed Care

Resuscitation 95 (2015) 202–222

Contents lists available at ScienceDirect

Resuscitation

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

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☆

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CoSTR= Consenso sulla Scienza con Raccomandazioni di Trattamento

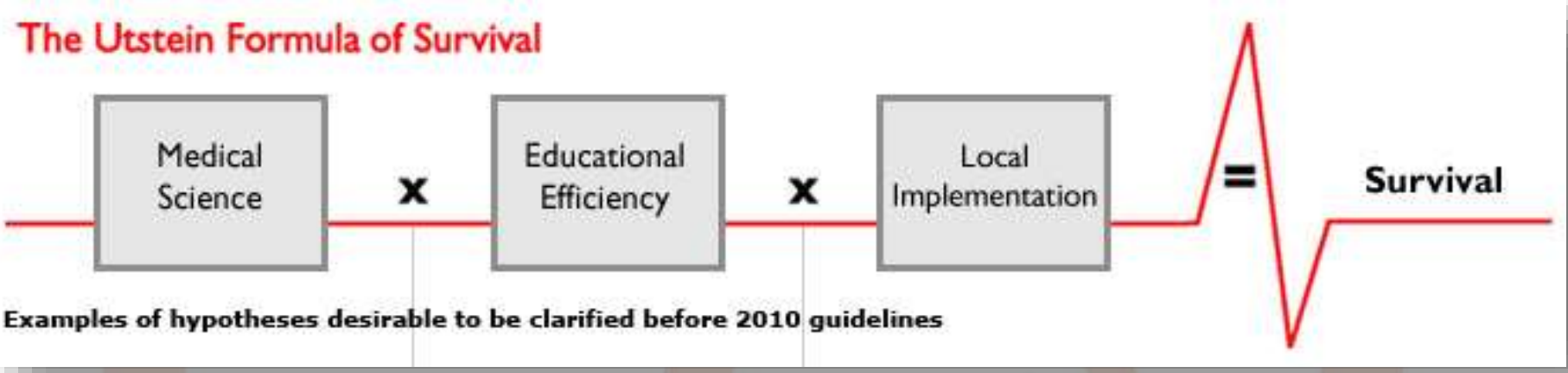
1. Pico question su argomento
2. Revisione letteratura
3. Livello di evidenza
4. Consensus
5. Forza della raccomandazione
6. Motivazione

Low level of evidence

Very low

Raccomandazione debole o forte

Expert Opinion



RICERCA x FORMAZIONE x ATTUAZIONE

La “formula” della sopravvivenza

Case Report

Bambino di 5 anni annegato piscina comunale

RCP prolungata sul posto dai bagnini e poi dal 118

Rosc dopo oltre 30 min Rcp ed adrenalina

Con ritmo non defibrillabile

Trasferito presso nostra terapia Intensiva

Intubato e Ventilato

All’ ammissione in PICU il bambino appare NON responsivo (poca sedazione) con I seguenti parametri vitali

- ✓RR (assistita) 30 x min.
- ✓O2 sat. 100
- ✓EtCO2 25 mm Hg
- ✓HR 140
- ✓BP 70/40
- ✓T 33°C

Trattamento post-rianimatorio

L'obiettivo è di ristabilire:

- Una funzione cerebrale normale
- Un ritmo cardiaco stabile
- Un'adeguata perfusione d'organo
- Un'adeguata qualità di vita

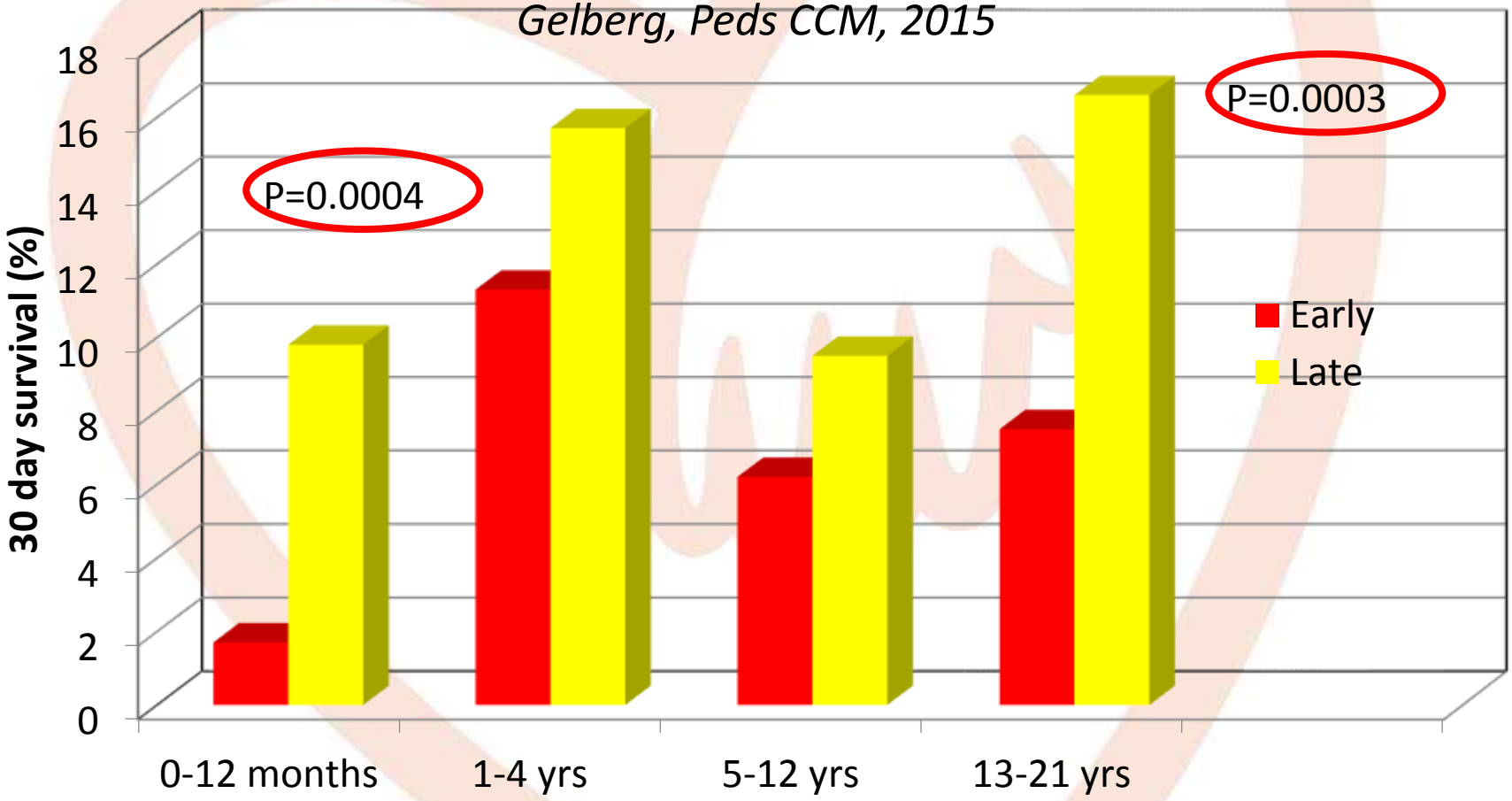
Pediatric Post-Cardiac Arrest Syndrome

% patients	IHCA Non-cv	IHCA CV-postop	IHCA CV-nonsurg	IHCA PICU CV-postop	OHCA
	NRCPR LO, 2011	NRCPR LO, 2011	NRCPR VN, 2006	HSC NdM, 2006	ROC DA, 2009
	N=1109	N=640	N=306	N=91	N=624
(%) Return of spontaneous circulation (ROSC)	53	67	53	82	10
(%) 24 hr survival	37	60	42	66	
(%) Survival to Hospital DC	23	37	28	25	6.4

Nadkarni, JAMA, 2006; De Mos, CCM, 2006; Ortmann, Circulation, 2011; Atkins, Circulation, 2009

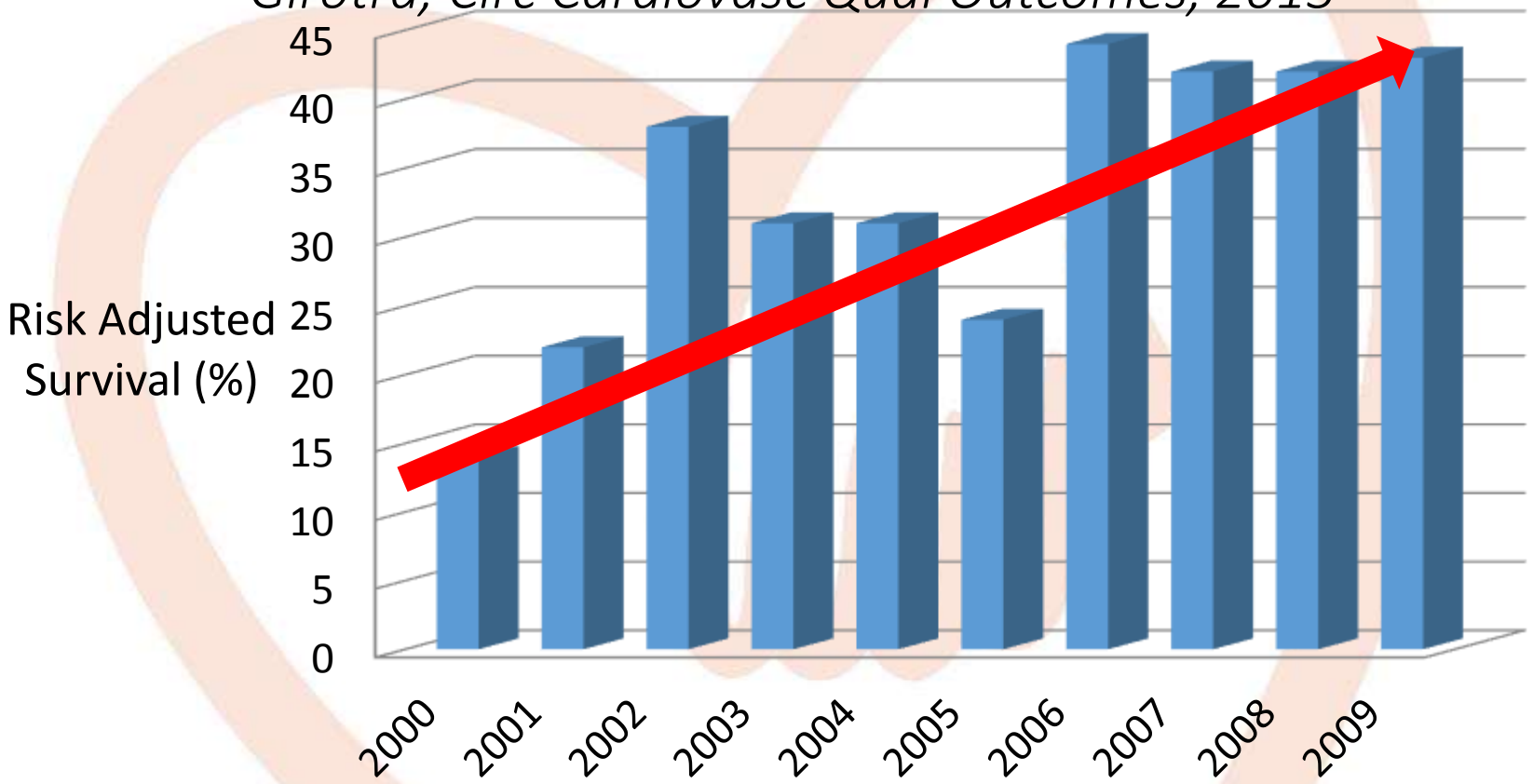
Improving Survival and Neurological Function for Younger Age Groups After Out-of-Hospital Cardiac Arrest in Sweden: A 20 Year Comparison

Gelberg, Peds CCM, 2015



Pediatric IHCA Survival to Hospital D/C

Girotra, Circ Cardiovasc Qual Outcomes, 2013



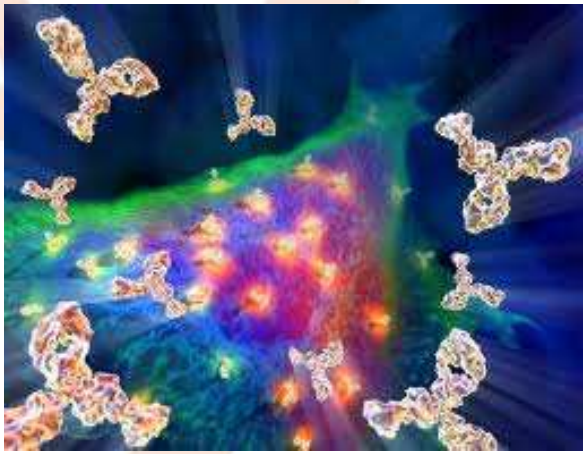
Survival trends *not* accompanied by higher rates of neurological disability among survivors over time (unadjusted *P for trend=0.32)*

- ✓RR (assistita) 30 min.
- ✓O2 saturation 100%
- ✓EtCO2 25 mm Hg
- ✓HR 140
- ✓BP 70/40
- ✓T 33°C

Post-ROSC oxygenation

Multiple animal studies:

- ventilation with 100% oxygen during and following resuscitation contributes to free radical–mediated reperfusion injury to the brain.



- may be associated with more neurologic deficit than ventilation with room air, especially when high Pa02 is experienced in the first hour post-ROSC

Post-ROSC oxygenation

What about neonatal studies?

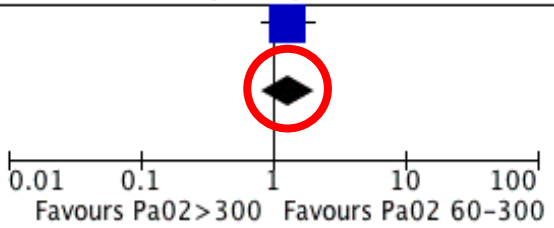
- Two meta-analyses of several randomized controlled trials co… neonatal resuscitation initi… room air versus 100%… showed increased survival… esuscitation was initiated… air.

D… 2004; Rabi, Resuscitation, 2007

Perinatal HIE is not Cardiac arrest

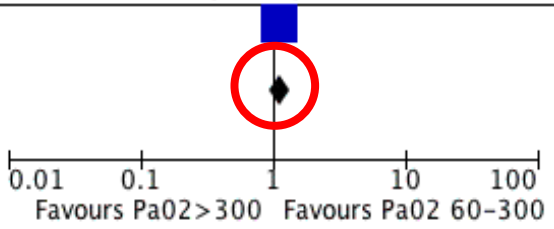
Study or Subgroup	Pa02>300 Events	Total	Pa02 60-300 Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Del Castillo, 2012	10	19	59	145	100.0%	1.29 [0.81, 2.07]
Total (95% CI)		**19**		**145**	**100.0%**	**1.29 [0.81, 2.07]**
Total events	10		59			

Heterogeneity: Not applicable
Test for overall effect: Z = 1.07 (P = 0.28)



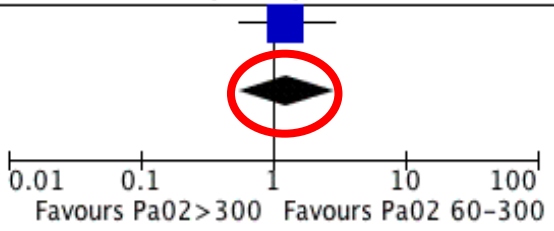
Study or Subgroup	Pa02>300 Events	Total	Pa02 60-300 Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Ferguson, 2012	91	207	478	1220	100.0%	1.12 [0.95, 1.33]
Total (95% CI)		**207**		**1220**	**100.0%**	**1.12 [0.95, 1.33]**
Total events	91		478			

Heterogeneity: Not applicable
Test for overall effect: Z = 1.34 (P = 0.18)



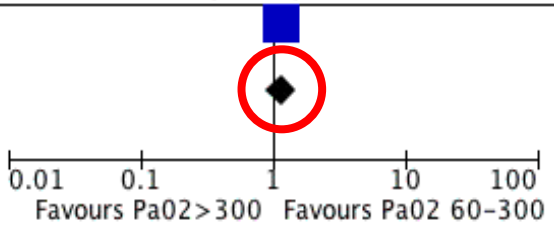
Study or Subgroup	Pa02>300 Events	Total	Pa02 60-300 Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Guerra, 2013	10	34	7	30	100.0%	1.26 [0.55, 2.90]
Total (95% CI)		**34**		**30**	**100.0%**	**1.26 [0.55, 2.90]**
Total events	10		7			

Heterogeneity: Not applicable
Test for overall effect: Z = 0.55 (P = 0.59)



Study or Subgroup	Pa02>300 Events	Total	Pa02 60-300 Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Bennett, 2013	57	87	37	66	100.0%	1.17 [0.90, 1.52]
Total (95% CI)		**87**		**66**	**100.0%**	**1.17 [0.90, 1.52]**
Total events	57		37			

Heterogeneity: Not applicable
Test for overall effect: Z = 1.16 (P = 0.24)



Pediatric Post-CA Hyperoxia

- 195 pediatric cardiac arrests: survive > 6 h
  - 54% hyperoxia, 22% hypoxia

  No relationship with survival

  Statler, CCM 2013

- 74 ped CA: 51% hyperoxia; 14% hypoxia

  No relationship with survival

  Guerra-Wallace, PCCM 2013

- PICANET: n= 1875 : 11% hyperoxia, 24% hypoxia
  Odds of death 1.25 (95% CI: 1.17-1.37)

  Ferguson, Circulation 2012

Post–Cardiac Arrest Oxygenation

- It may be reasonable for rescuers to target normoxemia after ROSC **(Class IIb, LOE B-NR)**.

- Arterial oxyhemoglobin saturation of 100% may correspond to a PaO2 anywhere between 80 and approximately 500mmHg (**target 94-99**)

- may be reasonable **(**when the necessary equipment is available**)** for rescuers to wean oxygen. Ideally, oxygen is titrated to a value appropriate to the specific patient condition.

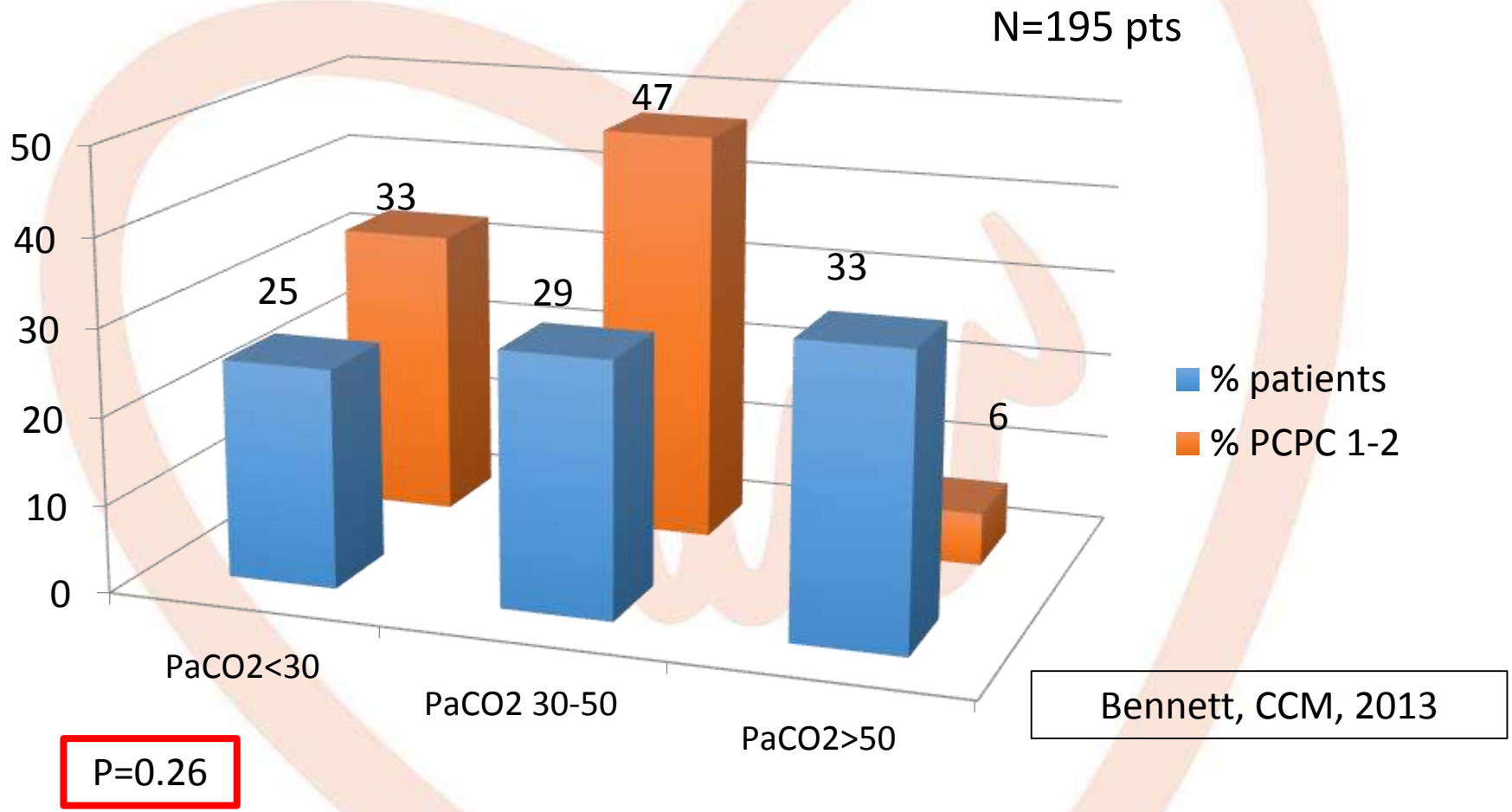
- ✓RR (assistita) 30 min.
- ✓O2 saturation 96 %
- ✓EtCO2 25 mm Hg
- ✓HR 140
- ✓BP 70/40
- ✓T 33°C

Hyperventilation post-ROSC

- Inadvertent hyperventilation is common
  - Proportion of CPR epochs with ventilation rates exceeding AHA guidelines (>10 bpm) was 63% (CI95 59–67%)
- Hyperventilation (increased RR or TV):
  - Hypocarbia shifts oxyhemoglobin dissociation curve
  - Reduce preload to heart
  - Cerebral vasoconstriction
- Systemic acidosis is common post-ROSC
  - usually metabolic not respiratory

McInnes, Resuscitation, 2011

Pediatric Post-arrest PaCO2 Management

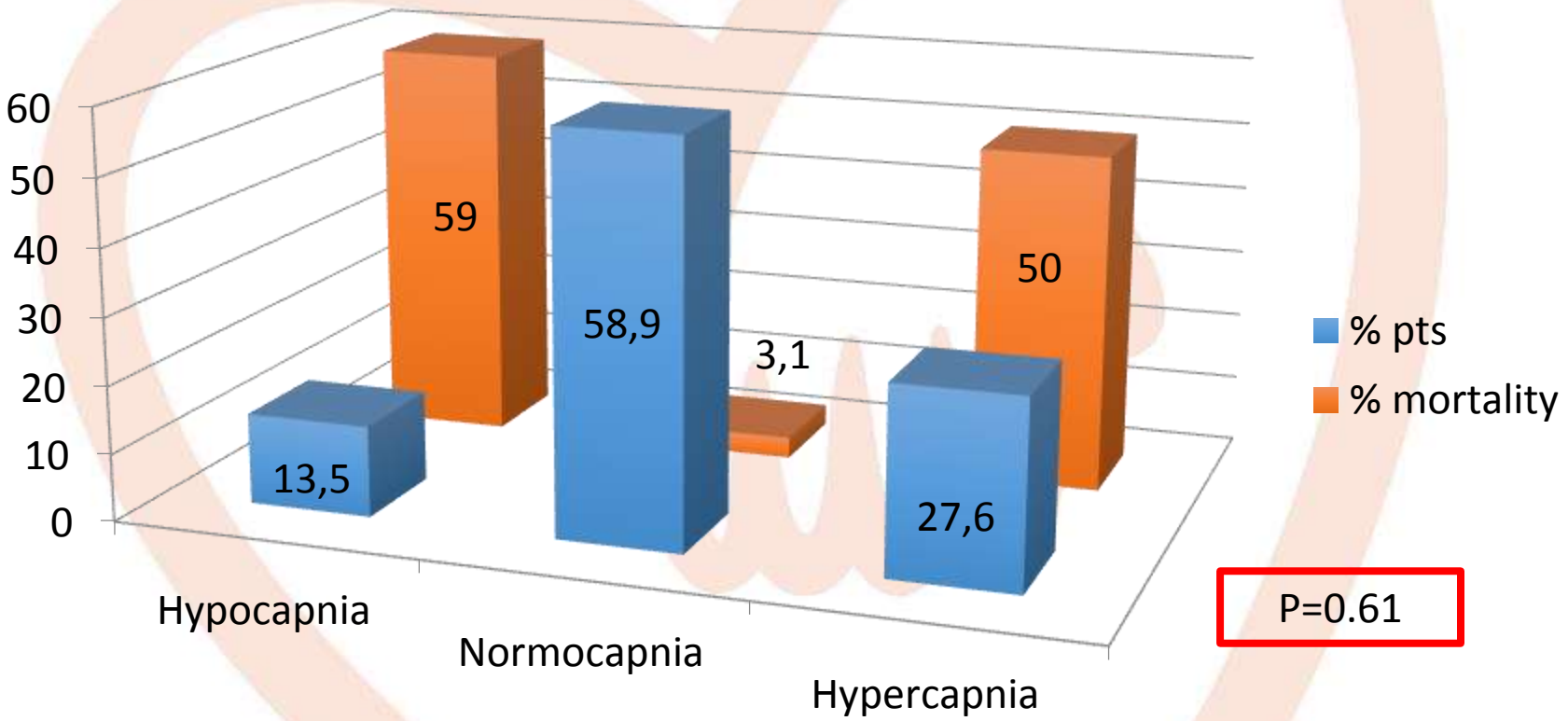


Bennett, CCM, 2013

P=0.26

Pediatric Post-arrest PaCO2 Management

Del Castillo, Resuscitation, 2012



Cerebrovascular reactivity to changes in arterial carbon dioxide tension is preserved in comatose patients post-ROSC *Buunk Stroke 1997*

Post–Cardiac Arrest PaCO2

- It is reasonable for practitioners to target a PaCo2 after ROSC that is appropriate to the specific patient condition, and limit exposure to severe hypercapnia or hypocapnia
- **(Class IIb, LOE C-LD).**

- Monitor exhaled Co2 (ETCO2) especially during transport and diagnostic procedures.
- **(Class IIa, LOE B).**

- ✓RR (assistita) 30 min.
- ✓O2 saturation 96%
- ✓EtCO2 34 mm Hg
- ✓HR 140
- ✓BP 70/40
- ✓T. 33°C

Post-Cardiac Arrest: Myocardial Dysfunction

Animal models (VF)

- *Myocardial stunning,* with an onset within 30 min post-ROSC, and function returning to normal within 24-48 hours of the insult
- Systolic and diastolic dysfunction (biventricular)

Kern, Circulation, 1997

Kern, J Am Coll Card, 1996

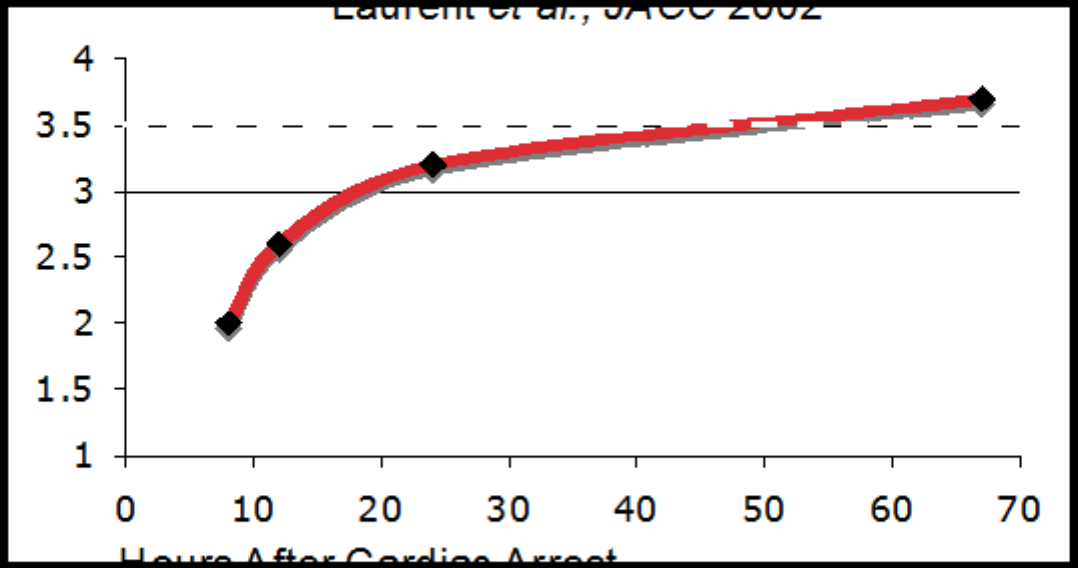
LV Systolic Function Following OHCA

- 58 patients admitted to CHOP PICU
- Echocardiogram within 24 hours of ROSC
- Decreased function vs Normal Function
- Only SVO2< 60 differentiated ECHO findings

After controlling for VF and vasopressor scores, patients with decreased function had 13.7 times higher odds or death

Conlon, submitted

Myocardial Function is Reversibly Depressed for 24 to 72 hours after Cardiac Arrest



Post-cardiac arrest myocardial dysfunction is responsive to inotropes and intravenous fluid

Post-CA Hypotension

- Project IMPACT: 8736 patients
- Hypotension (ICU SBP<90 within 1 hr): 47%

Mortality

- Hypotension 65%
- No hypotension 37%
- Odds of death 2.7 (95% CI: 2.5-3.0)

Trzeciak, CCM 2009

Pediatric Post-Arrest ICU Hypotension

- **PECARN: 383 children**
- Hypotension (SBP<5%ile within 6 hr): 56%

Mortality

- Hypotension 53%
- No hypotension 41%
- Odds of death: 1.71 (95% CI: 1.02, 2.89)

Topjian CCM, 2014

Post–Cardiac Arrest Fluids and Inotropes

Pediatric Post-ROSC Hypotension

Topjian, CCM, 2014

After controlling for patient and cardiopulmonary arrest characteristics, hypotension in the first 6 hours following ROSC was associated with:

Significantly increased odds of in-hospital mortality

adjusted odds ratio = 1.71; $p = 0.042$

Increased odds of unfavorable outcome

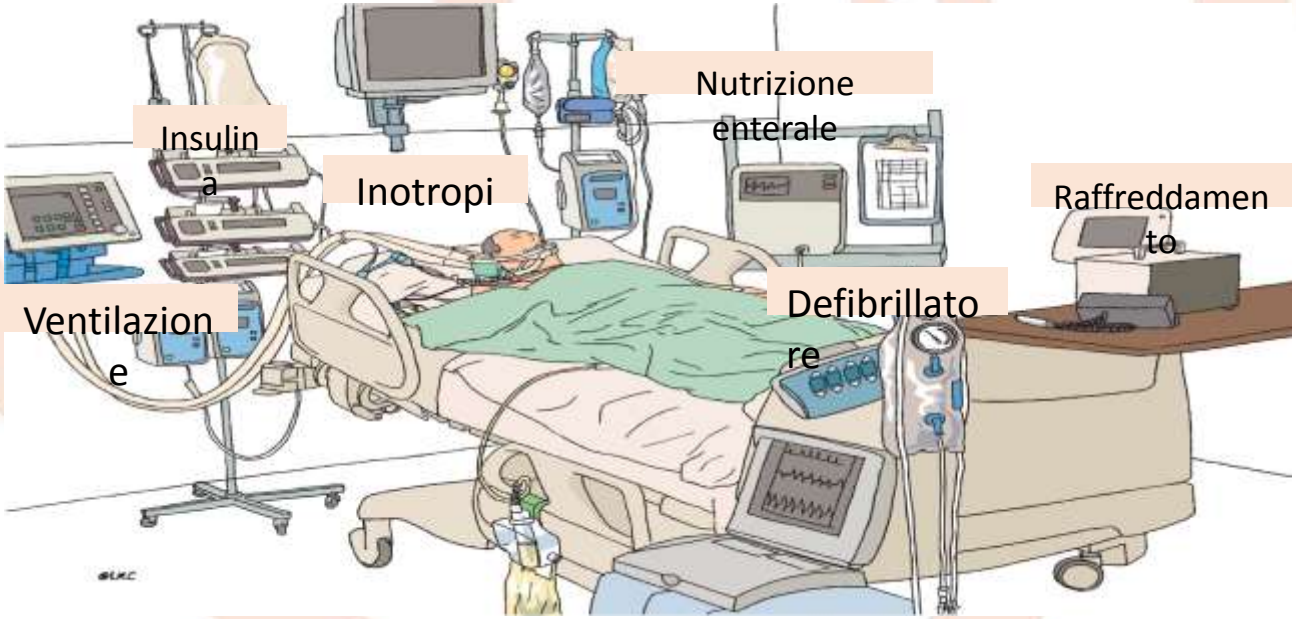
adjusted odds ratio = 1.83; $p = 0.032$.

Post–Cardiac Arrest Fluids and Inotropes

- After ROSC, we recommend that parenteral fluids and/or inotropes or vasoactive drugs be used to maintain a systolic blood pressure greater than 5th percentile for age **(Class I, LOE C-LD).**
- When appropriate resources are available, continuous arterial pressure monitoring is recommended to identify and treat hypotension **(Class I,LOE C-EO).**

Post–Cardiac Arrest Fluids and Inotropes

- It is reasonable to use an inodilator in a highly monitorated setting for tratment of myocardial dysfuction with increased systemic or pulmonary vascular resistence **(Class IIa, LOE B).**



BRAIN AUTOREGULATION

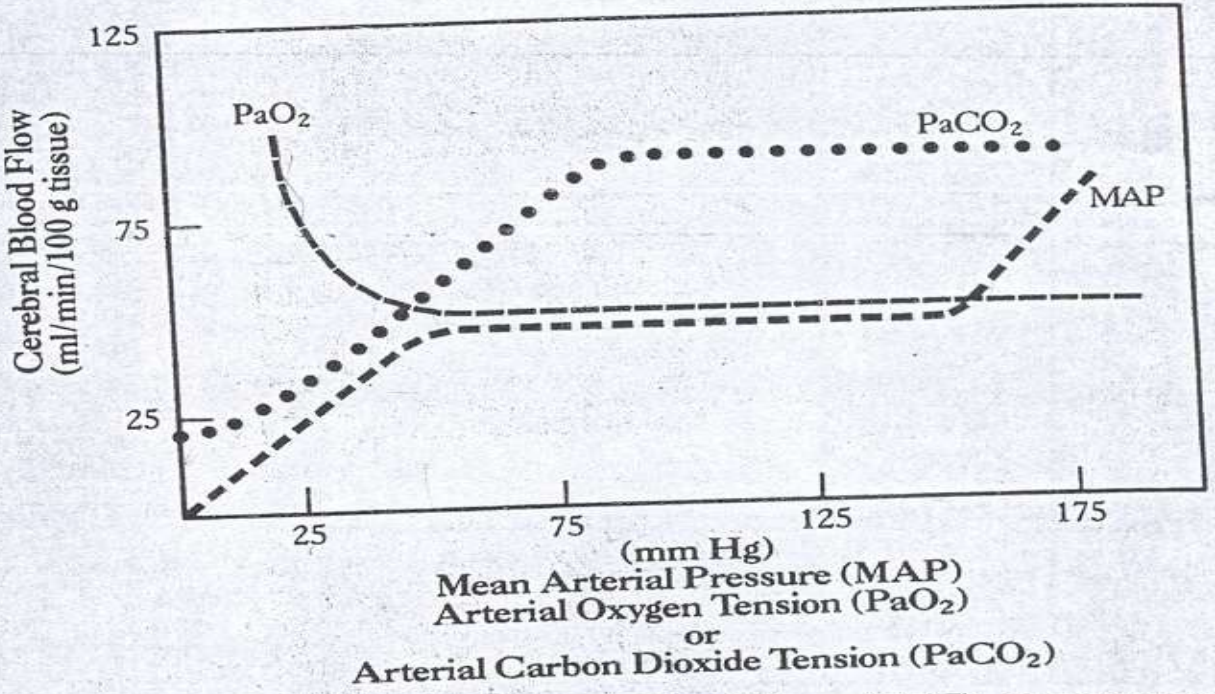
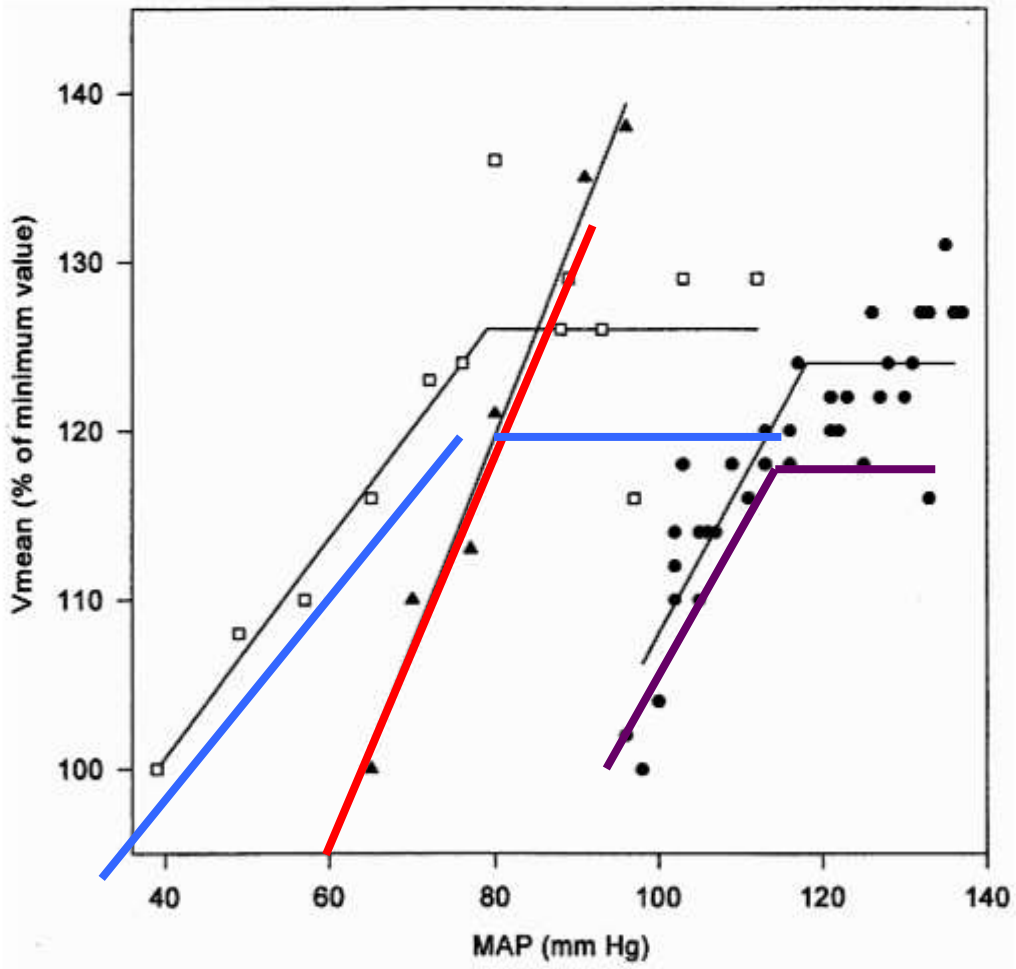


FIG. 111-3. Changes in cerebral blood flow (CBF) in response to changes in mean arterial pressure (MAP), arterial oxygen tension (Pa_{O_2}), or arterial carbon dioxide tension (Pa_{CO_2}). If autoregulation is intact, CBF remains constant as MAP varies between 50 and 150 mm Hg.

Post-resuscitation fluids and inotropic use

Examples of TCD Profiles (n=18 patients)

Sundgreen, Stroke, 2001



Impaired CBF autoregulation

- Autoregulation with no identifiable lower limited
- Right-shifted autoregulation

Claus, Stroke 2001

Boundles of Brain Management

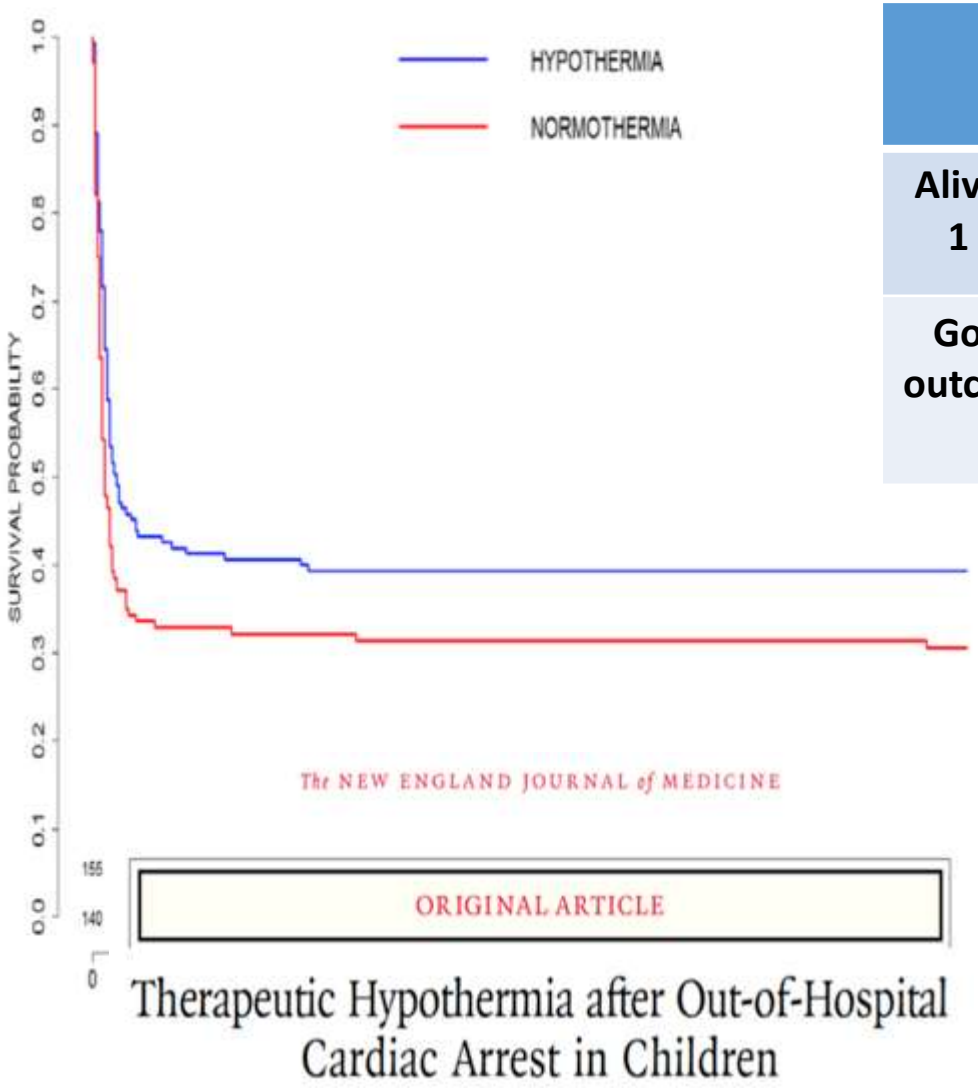
- Oxygen Titration
- BP Management
- Cerebral perfusion
- Temperature management
- Control of seizures
- Glucose control

All’ ammissione in PICU il bambino appare NON responsivo (poca sedazione) con i seguenti parametri vitali

- ✓RR (assisted) 30
- ✓O2 saturation 96%
- ✓EtCO2 34 mm Hg
- ✓HR 120
- ✓BP 90/45
- ✓T 33°C

Casistica Hypotermia post CA (GEMELLI)

	ALL (n.33)	Survivors (n.21) 63%	Dead (n.12) 37%	p
Age (mths, median; IQR)	36 (3.55;177.5)	48	35	0.846
Gender (M/F)	1.35	1.33	1.4	0.946
CA etiology (Tab.)	42.4 ?? airway obstruction	42.8 airway obstruction	41.6 airway obstruction	0.162
IN vs OUT of hospital (%)	13/20	11/13 IN 10/20 OUT	2/13 IN 10/20 OUT	**0.029**
Early brain edema score	2 (0.5-3.0)	1 (0;2.5)	3 (2.25;3)	**0.013**
Gap (before TH), median, hrs	2.5 (2.0;4.0)	2 (2;3.5)	4 (2;5)	0.243
CPR lenght - time to ROSC (min)	25 (17.5-35.0)	20 (10;35)	28.5 (25;45)	**0.006**
Blood pH 24hrs/48hrs	7.369/7.392	7.361/7.375	7.405/7.413	0.068 (24hrs) 0.042 (48hrs)
Prism III$_{24}$	32 (25;45)	32 (22;39.8)	44.5 (31;48.3)	**0.0019**
VIS$_{max}$	30 (21;37.5)	25 (15;30)	37.5 (31;43.75)	**0.0020**



	Hypothermia	Normothermia	
Alive at 1 yr	57/151 (38%)	39/136 (29%)	RD 9.1 OR 1.29 (0.93 to 1.79)
Good outcome	27/138 (20%)	15/122 (12%)	RD 7.3 OR 1.54 (0.86 to 2.76)

Post-ROSC fever associated with worse outcomes (*Bembea, 2010*)

Temperature Management

- For infants and children remaining comatose after OHCA, it is reasonable either to maintain 5 days of continuous normothermia (36°C to 37.5°C) or to maintain 2 days of initial continuous hypothermia (32°C to 34°C) followed by 3 days of continuous normothermia **(Class IIa, LOE B-R)**

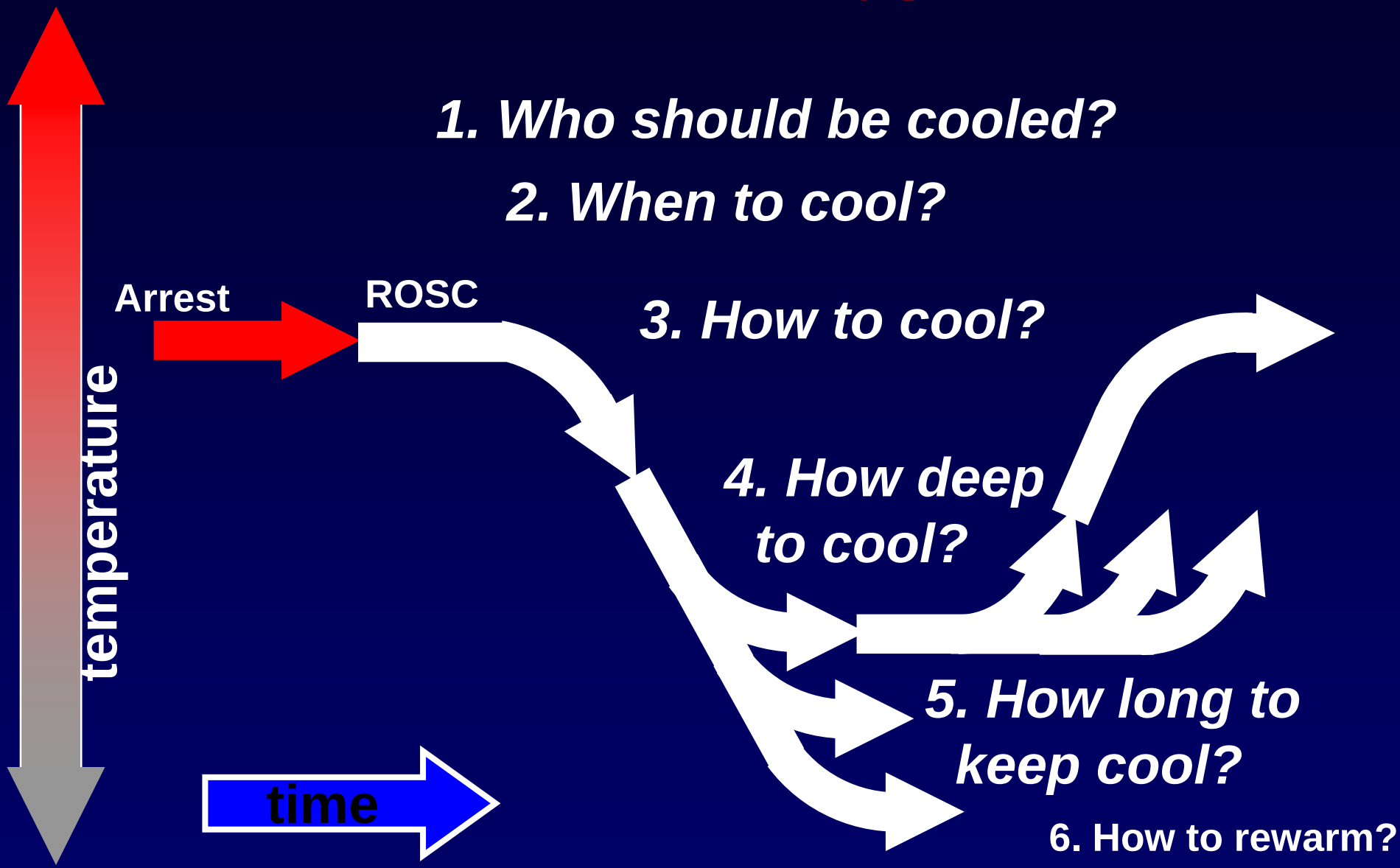
- For infants and children remaining comatose after IHCA there is insufficient evidence to recommend cooling over normothermia.

Temperature Management

- Continuous measurement of temperature is recommended **(Class I, LOE B-NR)**

- Fever (temperature 38°C or higher) should be aggressively treated after ROSC **(Class I, LOE B-NR)**

Questions about hypothermia



Slide modified from T. van den Hoek, MD, U Chicago

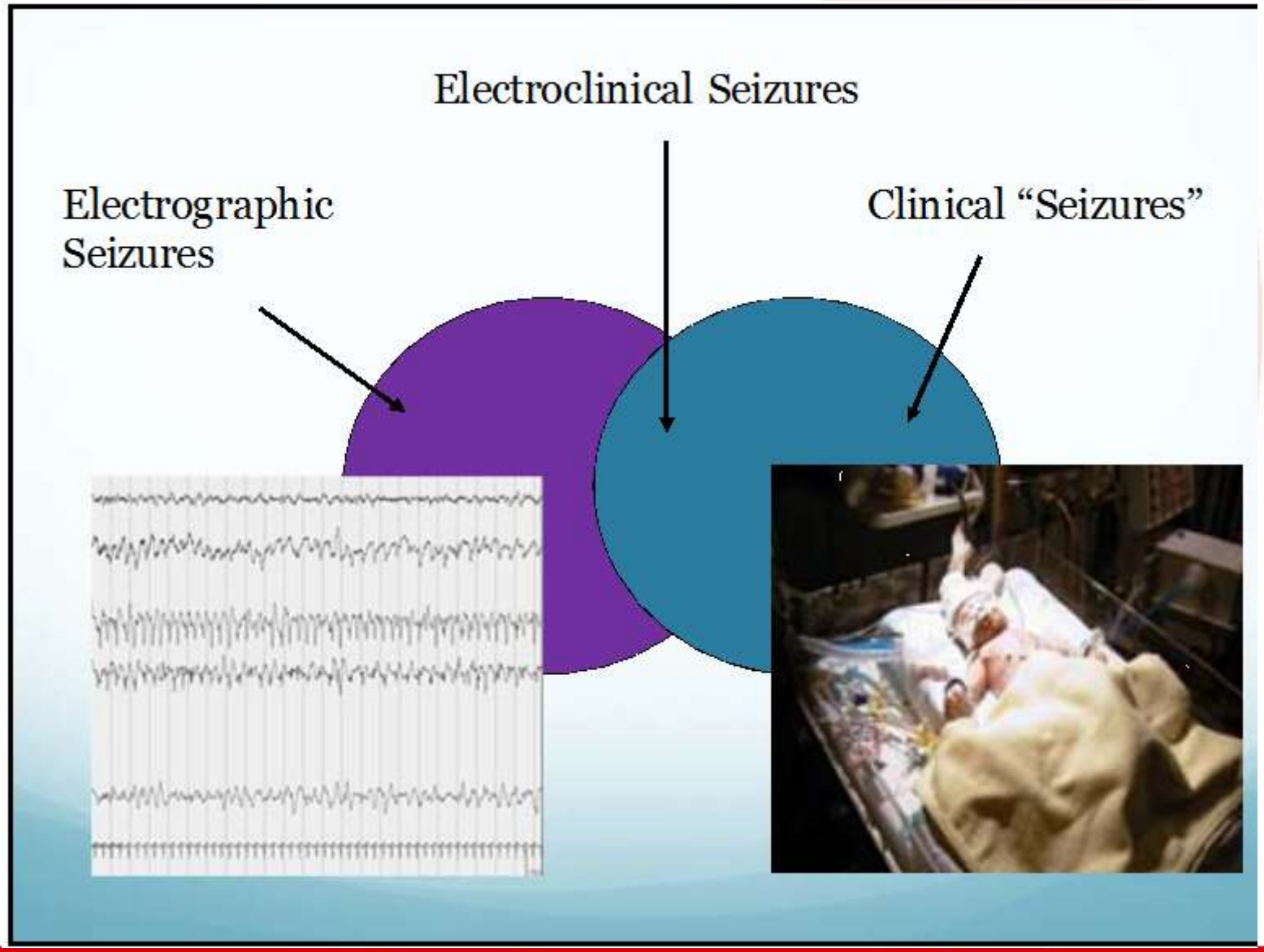
Dopo 12 ore dal ricovero in PICU negli ultimi 20 minuti si sono verificati ripetuti sbalzi della Pa, FC e Sat O2.

Si sospetta la presenza di crisi convulsive senza la presenza di movimenti tonico-clonico associati

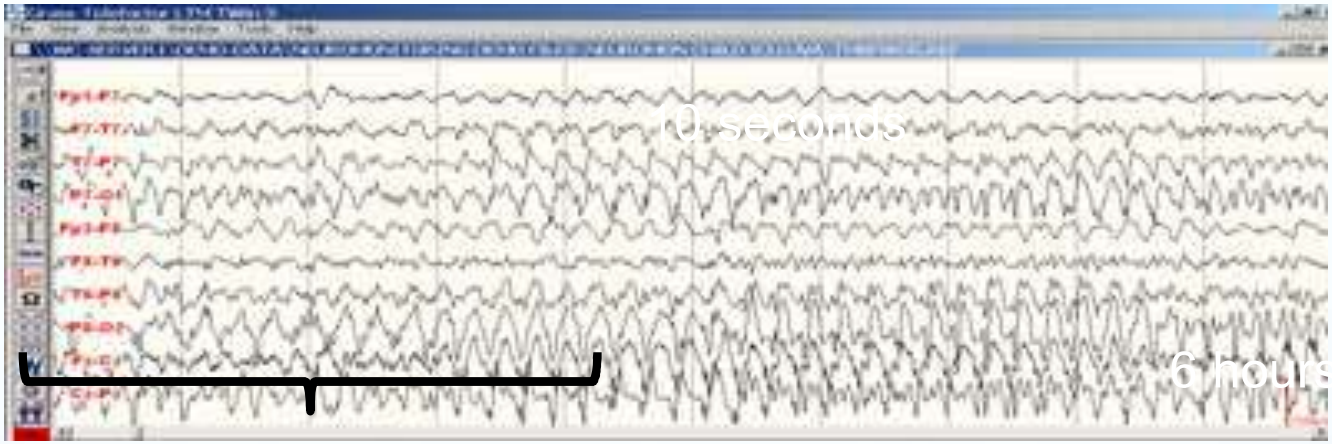
Electroencephalographic monitoring during hypothermia after pediatric cardiac arrest

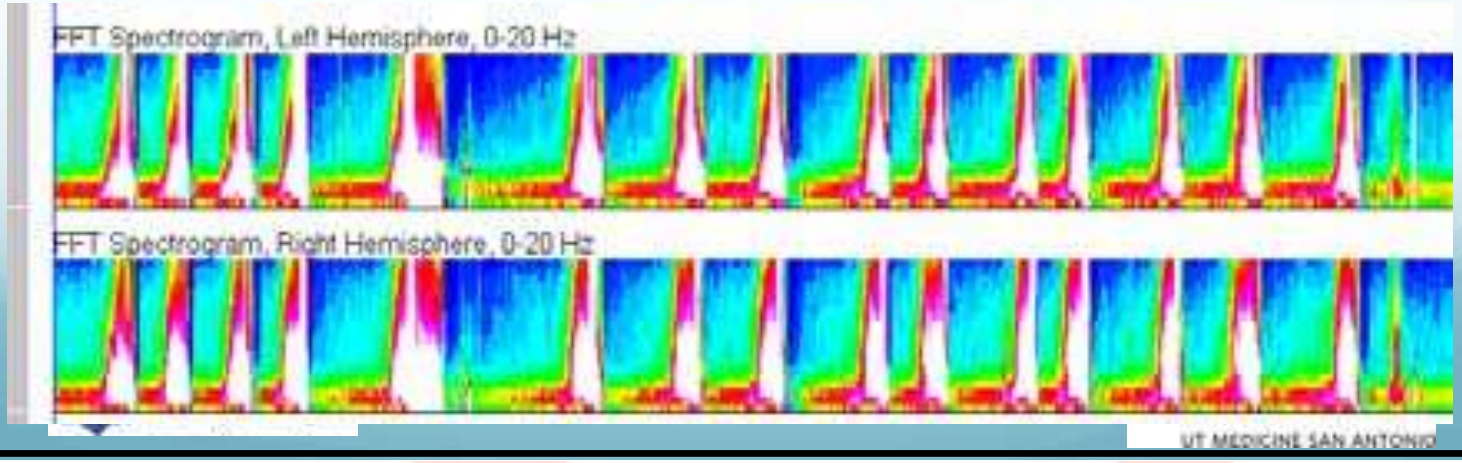
Abend Neurology 2009

- 19 children had continuous EEG monitoring during TTM
- Electrographic seizures occurred in 47%, and 32% of all patients developed status epilepticus
- *Seizures were nonconvulsive in 67%* and electrographically generalized in 78%
- Seizures commenced during the late hypothermic or rewarming periods


Electroclinical Seizures
Electrographic Seizures
Clinical "Seizures"

Could you find these seizures?





Electrographic Status Epilepticus is Associated with Worse Outcomes

	MORTALITY OR (95% CI)	↑ PCPC OR (95% CI)
No Seizures	ref	ref
Electrographic Seizures	1.3 (0.3, 5.1) p=0.74	1.2 (0.4, 3.9) P=0.77
Electrographic Status Epilepticus	5.1 (1.4, 18) p=0.01	17.3 (3.7, 80) P<0.001

Controlled for age, sex, acute etiology, EEG background, prior neurodevelopmental abnormality and EEG monitoring indication

Topjian, CCM, 2013

Post-ROSC Seizure Control and Prevention

- Aggressive anticonvulsant treatment (and prophylaxis) makes sense
  - to date no data exists to suggest that doing so alters outcome post-ROSC (in adults or children)
- Choice of treatment approach is personal and not directly evidence-based
- Caution needs to be paid to the hemodynamic consequences of drug choice for seizure control
- Continuous EEG monitoring should be considered post-ROSC, regardless of whether or not the patient is going to require paralytics

EEG Monitoring

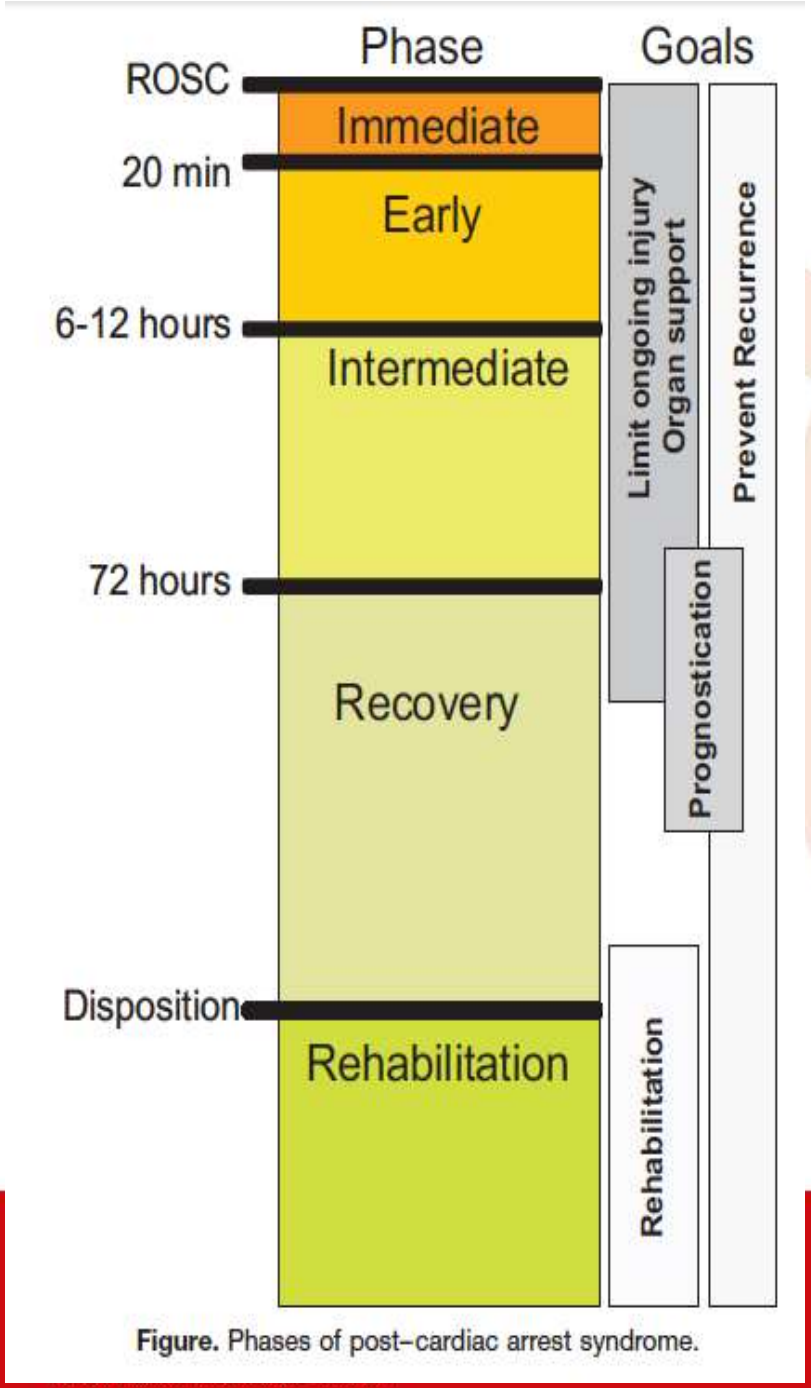


Figure. Phases of post–cardiac arrest syndrome.

Neumar, Circulation, 2006

Priorities post-ROSC?

- Prevent on-going primary injury (eg. Sepsis); (multi-system)
- Minimize (secondary) post-ROSC injury; (multi-system)
- Prognostication
- Allow for family centered care

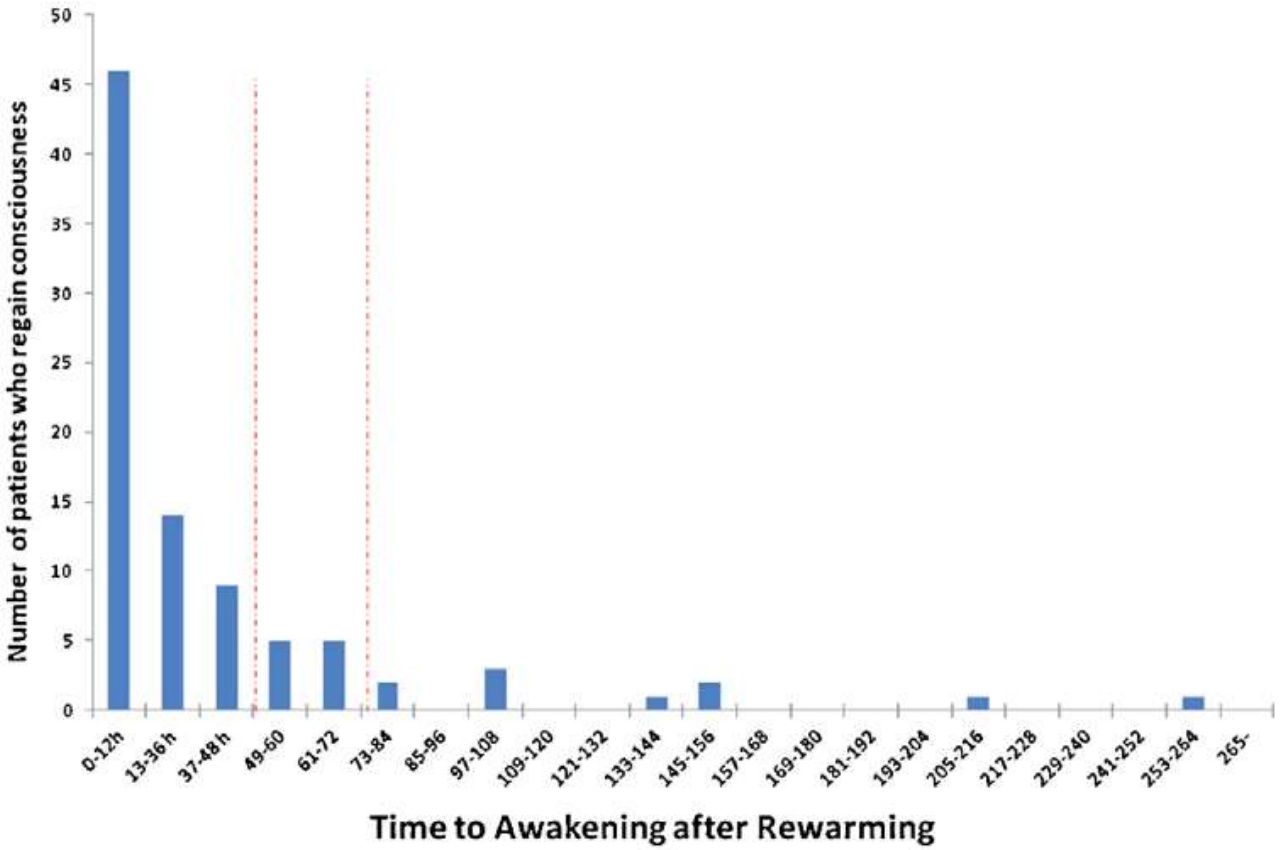


Fig. 2. Time to awakening after rewarming. Dashed lines indicate the 48 and 72 h timepoints.

Gold, Resuscitation, 2013

I Genitori chiedono di avere un colloquio e capire quali sono i rischi neurologici del bambino. L' infermiera riferisce che fra di loro hanno discusso riguardo all' intesinvità delle cure

Predictive Factors After Cardiac Arrest

- EEGs performed within the first 7 days after pediatric cardiac arrest may be considered in prognosticating neurologic outcome at the time of hospital discharge **(Class IIb, LOE C-LD)** but should not be used as the sole criterion.

- The reliability of any 1 variable for prognostication in children after cardiac arrest has not been established. Practitioners should consider multiple factors when predicting outcomes in infants and children who achieve ROSC after cardiac arrest **(Class I, LOE C-LD)**.

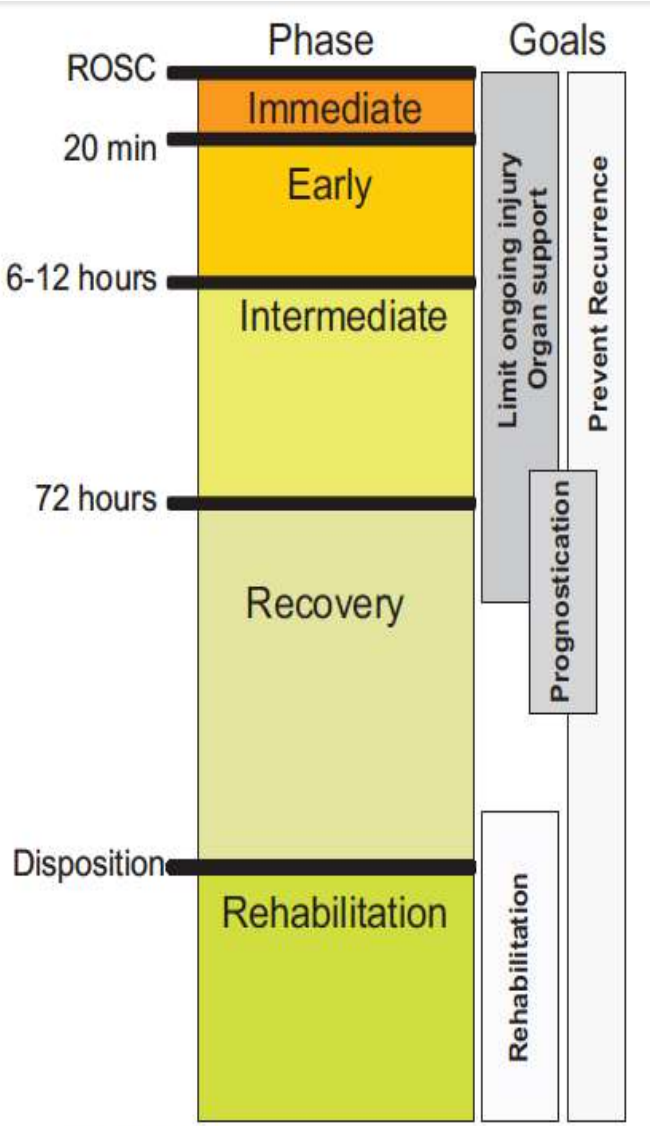


Figure. Phases of post–cardiac arrest syndrome.

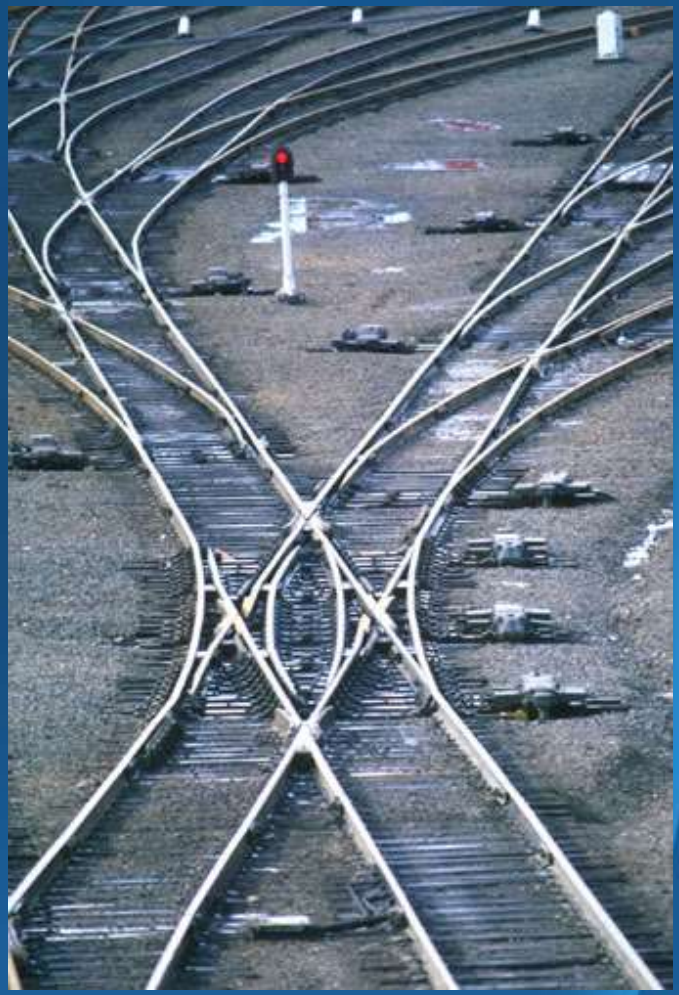
injury

t-ROSC

•Allow for family centered care

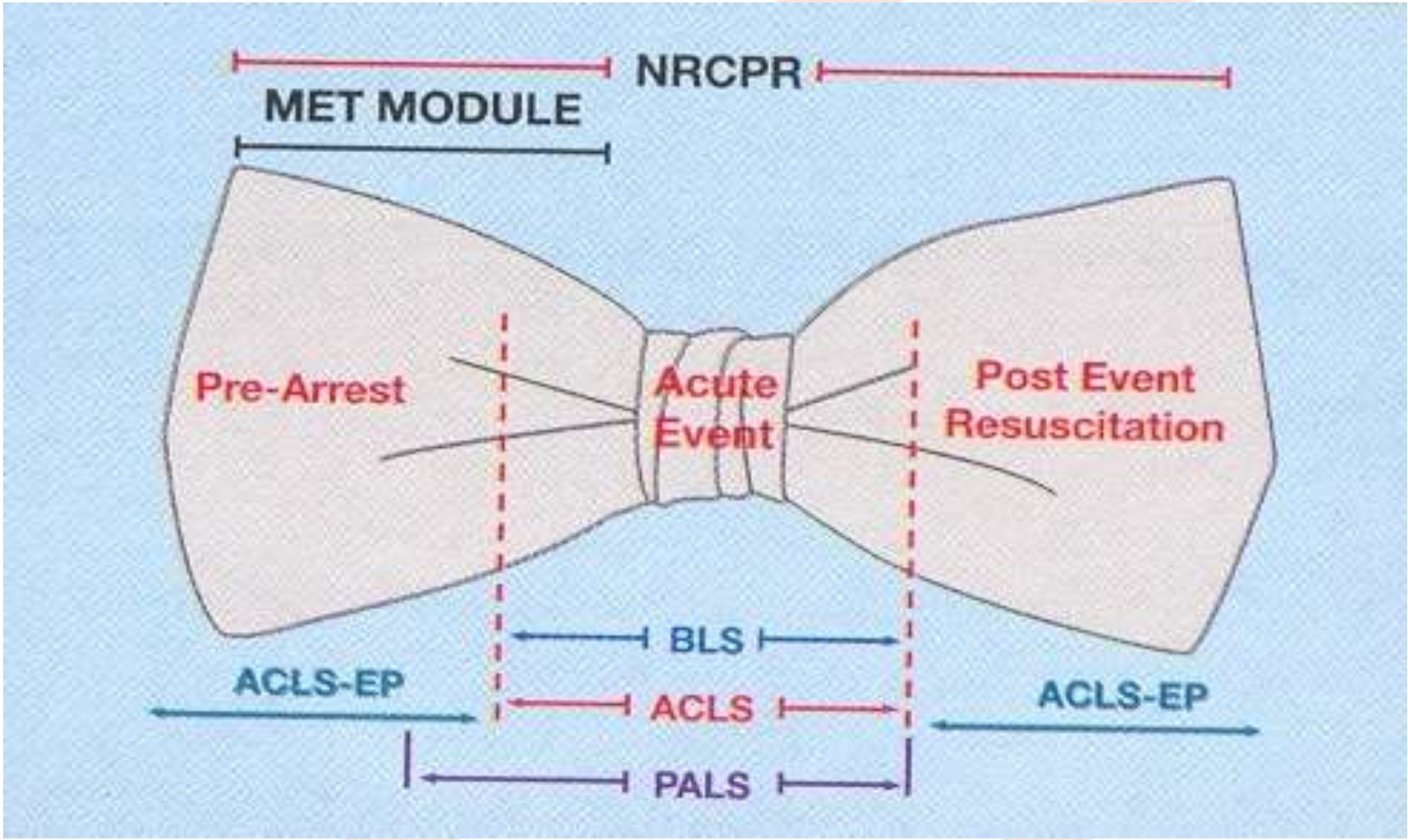
Sistemi Semplici

Sistemi Complessi



Formula-One for Survival!

Pit Stop Mentality


NRCPR
MET MODULE
Pre-Arrest
Acute Event
Post Event Resuscitation
BLS
ACLS-EP
ACLS
ACLS-EP
PALS

Domains of competencies

Sapere

Fare

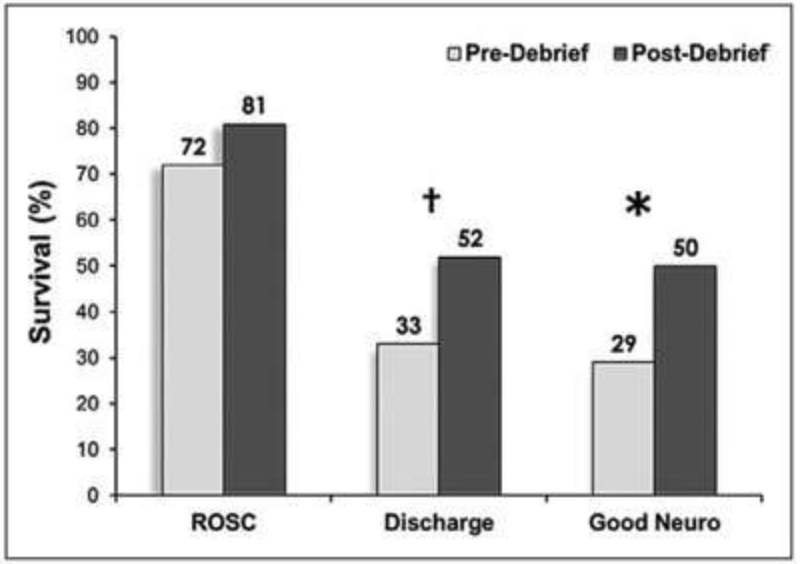
Comportarsi

Data Driven Debriefing in the Clinical Setting

- Adults
  - Improved ROSC from 44 to 59% (Edelson, 2008)

Children

Wolfe 2014

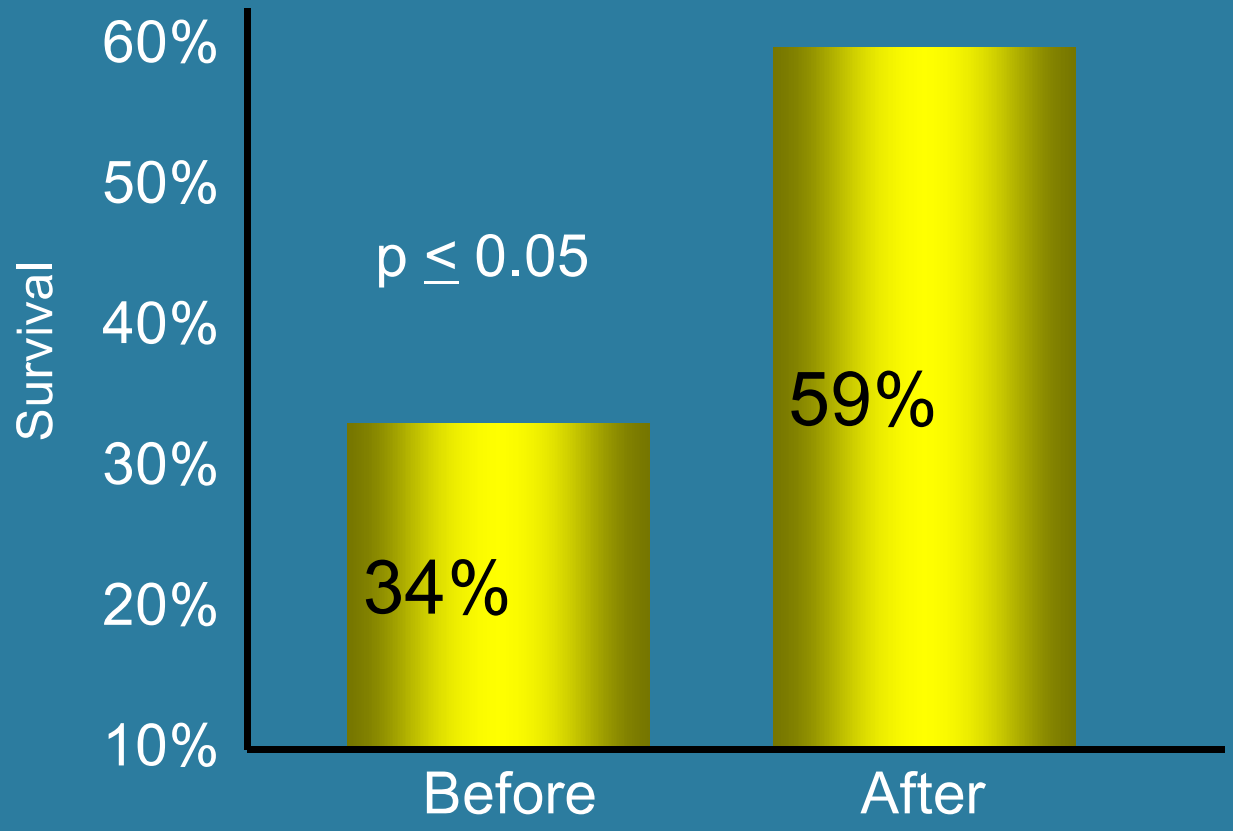


Improving future performance

It is reasonable for in-hospital systems of care to implement performance-focused debriefing of rescuers after IHCA in both adults and children (Class IIa, LOE C-LD).

Aggressive Post Resuscitation Care

Saves Lives



Pytte M, Jensen LP, Smedsrud C, Jacobsen D, Mangschau A, Sunde K. Oslo, Norway

Riassunto

- La sindrome post-arresto è complessa
- La qualità del trattamento post-rianimatorio influenza l'outcome finale
- Monitoraggio adeguato, trasferimento in sicurezza e ottimizzazione continua delle funzioni d'organo
- Difficile formulare una prognosi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