CONGRESSO NAZIONALE IRC 2023

Vicenza

Italian Resuscitation Conference 2023

20 • 21 OTTOBRE

Vicenza Convention Centre

LA RIVOLUZIONE DEI SISTEMI

IRC | Italian Resuscitation Council

Il post ROSC nel bambino: target e strategie

Giovanni Babini

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IRC Italian Resuscitation Council

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LA RIVOLUZIONE DEI SISTEMI

350.000 – 420.000 casi/anno
126.52/100 000 persone/anno

275.000 - 400.000 casi /anno
84.0/100 000 persone/anno

Tentativi di rianimazione 49.0-56.0/100.000/anno

>5000 casi/anno
8.04/100 000 bambini/anno

3.0-19.7/100 000 bambini/anno

Tentativi di rianimazione 70-84%

Gräsner et al. Resuscitation 2016, Gräsner et al. Resuscitation 2020
Andersen et al. JAMA 2019, Atkins et al. Circulation 2009
Rajan et al. Resuscitation 2015

Survival After Out-of-Hospital Cardiac Arrest in Children

Natalie Jayaram, MD, MSB; Bryan McNally, MD, MPH; Fengming Tang, MS; Paul S. Chan, MD, MSc

J Am Heart Assoc. 2015

Overall, 162 (8.2%) children survived to hospital discharge.

Association of Bystander Cardiopulmonary Resuscitation With Overall and Neurologically Favorable Survival After Pediatric Out-of-Hospital Cardiac Arrest in the United States

A Report From the Cardiac Arrest Registry to Enhance Survival Surveillance Registry

Maryam Y. Naim, MD; Rita V. Burke, PhD, MPH; Bryan F. McNally, MD, MPH; Lihai Song, MS; Heather M. Griffis, PhD; Robert A. Berg, MD; Kimberly Vellano, MPH; David Markenson, MD; Richard N. Bradley, MD; Joseph W. Rossano, MD, MS

JAMA Pediatrics February 2017 Volume 171, Number 2

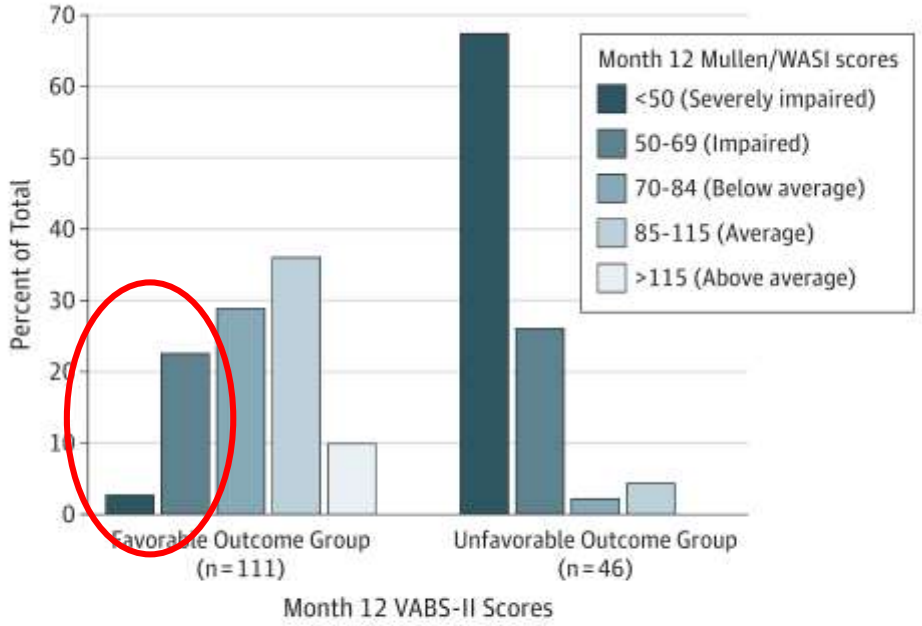
The overall survival rate was 11.3% (440 of 3900), and the neurologically favorable survival rate was 9.1% (354 of 3900).

Neuropsychological Outcomes of Children 1 Year After Pediatric Cardiac Arrest

Secondary Analysis of 2 Randomized Clinical Trials

Beth S. Slomine, PhD; Faye S. Silverstein, MD; James R. Christensen, MD; Kent Page, MStat; Richard Holubkov, PhD; J. Michael Dean, MD, MBA; Frank W. Moler, MD, MS

JAMA Neurology December 2018



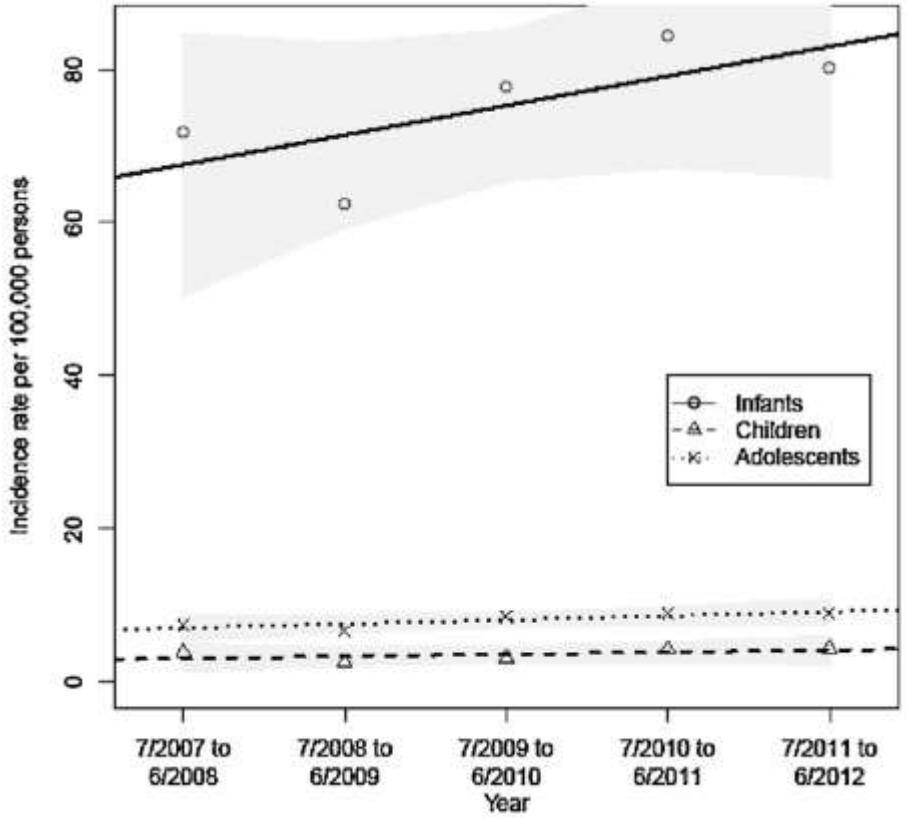
Mullen indicates Mullen Scales of Early Learning; VABS-II, Vineland Adaptive Behavior Scales, Second Edition; and WASI indicates Wechsler Abbreviated Scale of Intelligence.

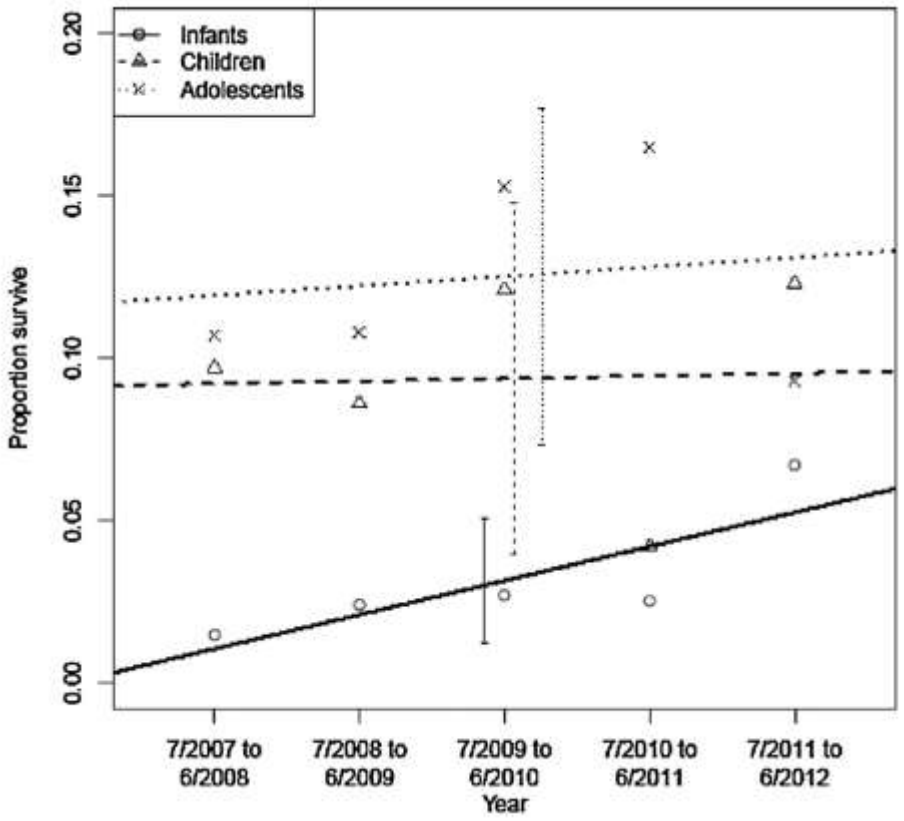
Multipli disturbi presenti nei pazienti con outcome "favorevole"

- Funzioni esecutive
- Movimento fine
- Funzioni visiomotorie
- Memoria visiva

Unchanged pediatric out-of-hospital cardiac arrest incidence and survival rates with regional variation in North America☆

E.L. Fink et al. / Resuscitation 107 (2016) 121–128





RESEARCH Open Access

Survival of pediatric patients after cardiopulmonary resuscitation for in-hospital cardiac arrest: a systematic review and meta-analysis

Melaku Bimerew[1*], Adam Wondmieneh[1], Getnet Gedefaw[2], Teshome Gebremeskel[1], Asmamaw Demis[1] and Addisu Getie[1]

Bimerew *et al. Italian Journal of Pediatrics* (2021) 47:118

SOPRAVVIVENZA ALLA DIMISSIONE OSPEDALIERA 46%

Table 1 Characteristics of research articles included in this systematic review and meta-analysis, 2020

S. No	Author	Publi cation year	Country	Continent	Income level	Sample size	SHD (%)
1	Appiah J et al. [24]	2018	South Africa	Africa	Upper-middle income	83	62.65
2	Shikuku DN et al. [25]	2018	Kenya	Africa	Lower-middle income	24	45.83
3	Alten et al. [26]	2017	North America	America	High income	470	54.04
4	Anton-Martin P et al. [27]	2020	United states	America	High income	73	43.84
5	Barbaro RP et al. [28]	2017	United states	America	High income	8575	41.94
6	Berg et al. [29]	2016	United states	America	High income	139	45.32
7	Berg et al. [30]	2018	United states	America	High income	164	46.95
8	Beshish AG et al. [31]	2018	Michigan	America	High income	80	47.50
9	Brown S et al. [32]	2018	Washington	America	High income	52	48.08
10	Burke CR et al. [33]	2017	United states	America	High income	53	49.06
11	Foglia et al. [34]	2017	Pennsylvania	America	High income	113	61.06
12	Geisser D et al. [35]	2019	Massachusetts	America	High income	295	41.69
13	Holmberg et al. [36]	2019	United states	America	High income	13,184	45.50
14	Hornik et al. [37]	2016	North America	America	High income	2231	50.52
15	Shakoor A et al. [38]	2019	New York	America	High income	70	54.29
16	Torres-Andres et al. [39]	2018	United states	America	High income	55	67.27
17	Assar S et al. [40]	2016	Iran	Asia	Upper-middle income	279	11.83
18	Chen GL et al. [41]	2018	Asia pacific	Asia	Low income	321	50.78
19	Erek et al. [42]	2017	Turkey	Asia	Upper-middle income	25	20.00
20	Kabbani et al. [16]	2019	Saudi Arabia	Asia	High income	15	80.00
21	Mok YH et al. [43]	2016	Singapore	Asia	High income	51	45.10
22	Rathore V et al. [44]	2016	North India	Asia	Lower-middle income	314	14.01
23	Adamski J et al. [45]	2016	Poland	Europe	High income	285	53.33
24	Kramer P et al. [46]	2020	Germany	Europe	High income	72	36.11
25	Skellett S et al. [47]	2020	United kingdom	Europe	High income	1456	54.19

SHD Survival to Hospital Discharge

Table 3. Rhythm-Specific Rates of Unadjusted Survival to Discharge by Calendar Year

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	*P* for Trend
Asystole, % (n/N)	20.0 (3/15)	38.1 (8/21)	21.2 (7/33)	23.3 (10/43)	20.5 (8/39)	20.6 (13/63)	47.4 (18/38)	45.0 (18/40)	31.3 (10/32)	31.3 (5/16)	0.05
PEA, % (n/N)	12.5 (1/8)	12.5 (1/8)	46.5 (6/13)	34.5 (10/29)	33.3 (13/39)	26.2 (16/61)	39.4 (26/66)	39.4 (37/94)	40.9 (61/149)	41.8 (28/67)	0.03
VF and pulseless VT, % (n/N)	0 (0/5)	0 (0/8)	50.0 (9/18)	41.2 (7/17)	40.0 (8/20)	24.0 (6/25)	52.4 (11/21)	45.0 (9/20)	50.0 (6/12)	36.4 (4/11)	0.11

Unadjusted rates for survival to discharge are reported separately for patients with asystole, pulseless electrical activity (PEA), and ventricular fibrillation (VF) and pulseless ventricular tachycardia (VT) by calendar year.

Table 4. Risk-Adjusted Rates* of Survival Outcomes by Calendar Year

	2000 (n=28)	2001 (n=37)	2002 (n=64)	2003 (n=89)	2004 (n=98)	2005 (n=149)	2006 (n=125)	2007 (n=154)	2008 (n=193)	2009 (n=94)	Adjusted RR per 1 y (95% CI)	*P* for Trend
Survival to discharge, %	14.3	22.5	37.9	31.0	30.8	24.3	44.5	42.0	42.1	43.4	1.08 (1.01–1.16)	0.02
Acute resuscitation survival,† %	42.9	64.3	74.9	55.6	72.3	63.3	79.7	74.6	80.3	81.2	1.04 (1.01–1.07)	0.006
Postresuscitation survival,‡ %	33.3	36.3	49.8	53.1	42.4	38.9	56.4	56.7	52.5	53.6	1.04 (0.98–1.09)	0.17

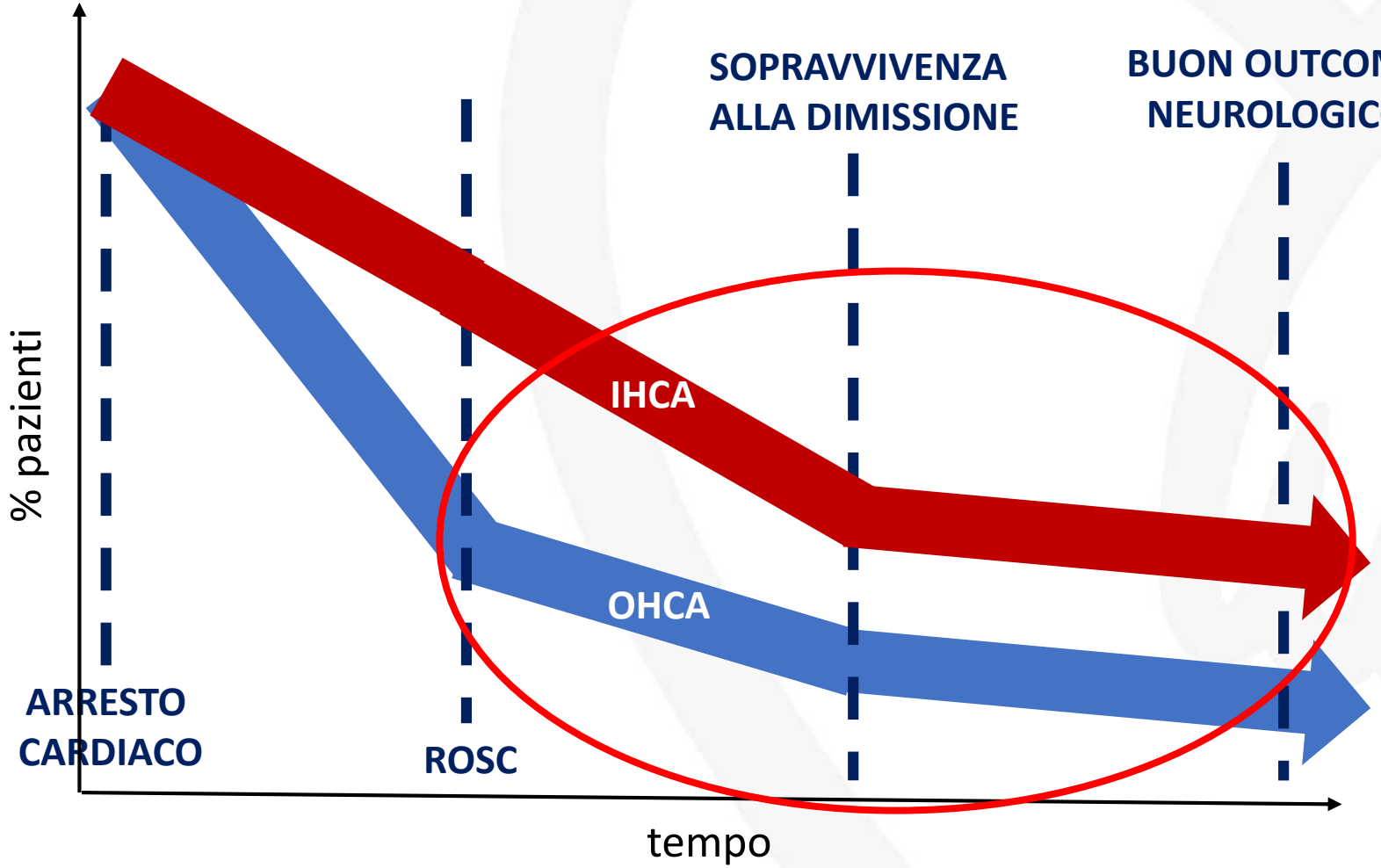
CI indicates confidence interval; RR, rate ratio.

*Risk-adjusted rates and adjusted RRs per year for the study outcomes of survival to discharge, acute resuscitation survival, and postresuscitation survival are reported for the overall cohort by calendar year. Risk-adjusted rates for each calendar year were obtained by multiplying the observed rate for the reference year (2000) with the corresponding RRs for 2001 through 2009 from a model evaluating calendar year as a categorical variable. Rates are adjusted for age groups, sex, race, initial cardiac arrest rhythm, heart failure this admission, heart failure before admission, hypotension/hypoperfusion, respiratory insufficiency, baseline depression in central nervous system function, acute central nervous system nonstroke event, pneumonia, assisted/mechanical ventilation, use of vasoactive agents, use of extracorporeal membrane oxygenation during resuscitation, hospital location, use of a hospitalwide response, and years of participation in the registry.

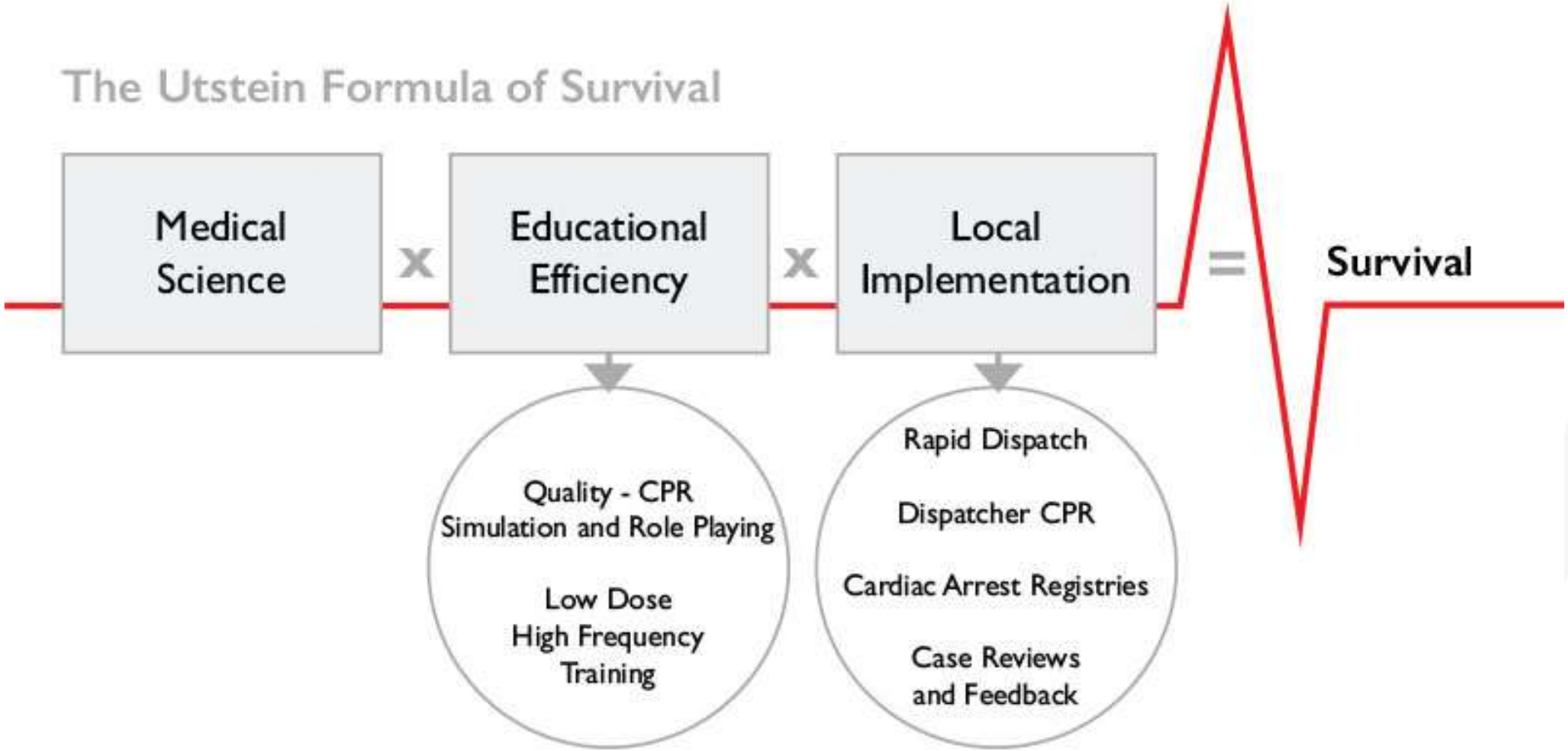
†Acute resuscitation survival was determined by the number of patients with return of spontaneous circulation for at least 20 minutes divided by the number of patients with a cardiac arrest.

‡Postresuscitation survival was determined by the number of patients with acute resuscitation survival who survived to hospital discharge divided by the number surviving the acute resuscitation.

Girotra et al. Circ Cardiovasc Qual Outcomes.2013


SOPRAVVIVENZA
ALLA DIMISSIONE
BUON OUTCOME
NEUROLOGICO
% pazienti
IHCA
OHCA
ARRESTO
CARDIACO
ROSC
tempo

The Utstein Formula of Survival



ILCOR Summary Statement

2017 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations Summary☆

ILCOR Summary Statement

2018 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations Summary

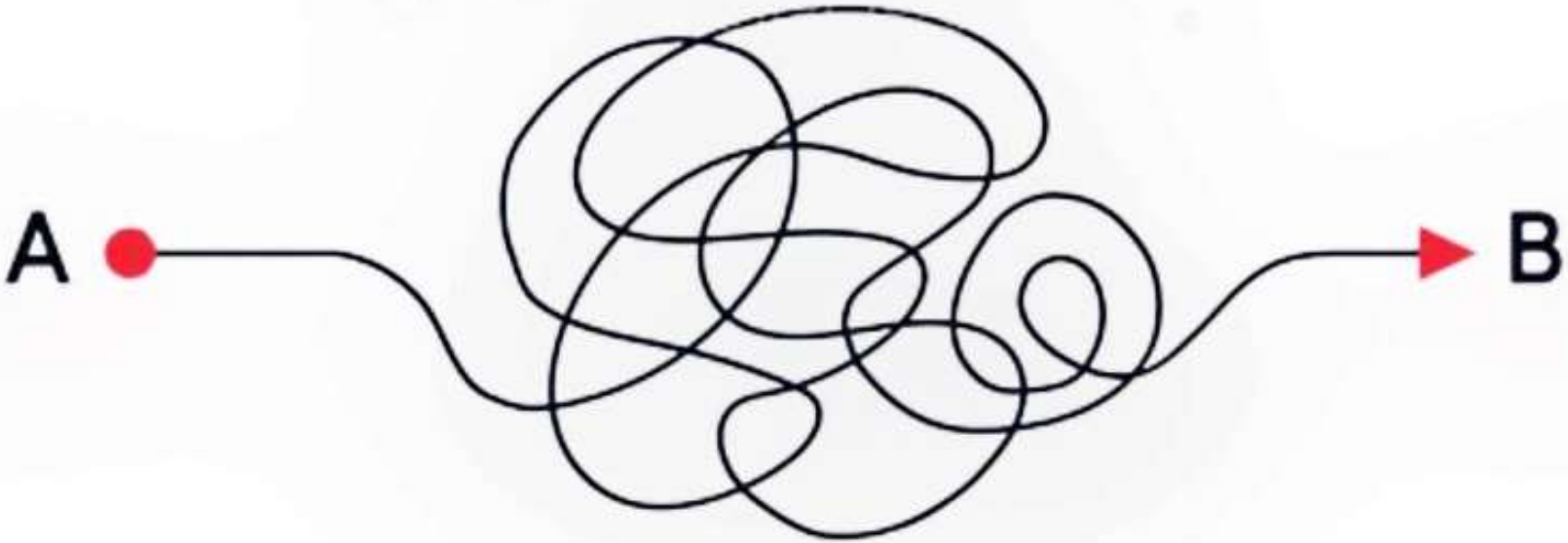
2019 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations☆,☆☆

Pediatric Life Support

2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations☆

Expectation

Reality



European Resuscitation Council Guidelines 2021: Paediatric Life Support

Patrick Van de Voorde[a,b,], Nigel M. Turner[c], Jana Djakow[d,e], Nieves de Lucas[f], Abel Martinez-Mejias[g], Dominique Biarent[h], Robert Bingham[i], Olivier Brissaud[j], Florian Hoffmann[k], Groa Bjork Johannesdottir[l], Torsten Lauritsen[m], Ian Maconochie[n]*

RESUSCITATION 161 (2021) 327 –387

Management post-ROSC

Evidence on the impact of treating centre characteristics (or more broadly regional healthcare organisation) on outcome of children with ROSC after IHCA or OHCA is conflicting and difficult to interpret because of many confounders.[129,799–801] This should be a research priority. Pending further data, it is preferable to admit children who have been resuscitated from CA to a facility with the necessary competences and resources for proper post-ROSC neuroprotective care, organ- and/or life supporting treatments, comprehensive neurological assessment and psychosocial support.[802]

Blood pressure

The ILCOR paediatric taskforce performed an EvUp (PLS 820) on this topic.[143] The authors identified five observational studies supporting the conclusion that post-CA hypotension less than the 5th percentile for age is associated with worse outcomes (appendix RR 36.1).[803–807] One paper demonstrated that hypertension immediately after CA is associated with improved survival. However, children who require higher doses of vasopressor support have lower rates of survival to hospital discharge.

Oxygenation & ventilation

The paediatric ILCOR taskforce performed a SR on oxygenation and ventilation targets after ROSC (appendix RR 36.2).[143] They suggest that rescuers measure PaO_2 after ROSC and target a value appropriate to the specific condition of the child. In the absence of specific patient data, rescuers should target normoxemia after ROSC (weak recommendation, very-low-quality evidence). Rescuers should also measure $PaCO_2$ after ROSC and target normocapnia (weak recommendation, very-low-certainty evidence). Adjustments to the target $PaCO_2$ should be considered for specific populations where normocapnia may not desirable (e.g. chronic lung disease with chronic hypercapnia, single ventricle physiology). It is unclear if a strategy of permissive mild hypercapnia could be beneficial in ventilated children with respiratory failure.

Targeted temperature management

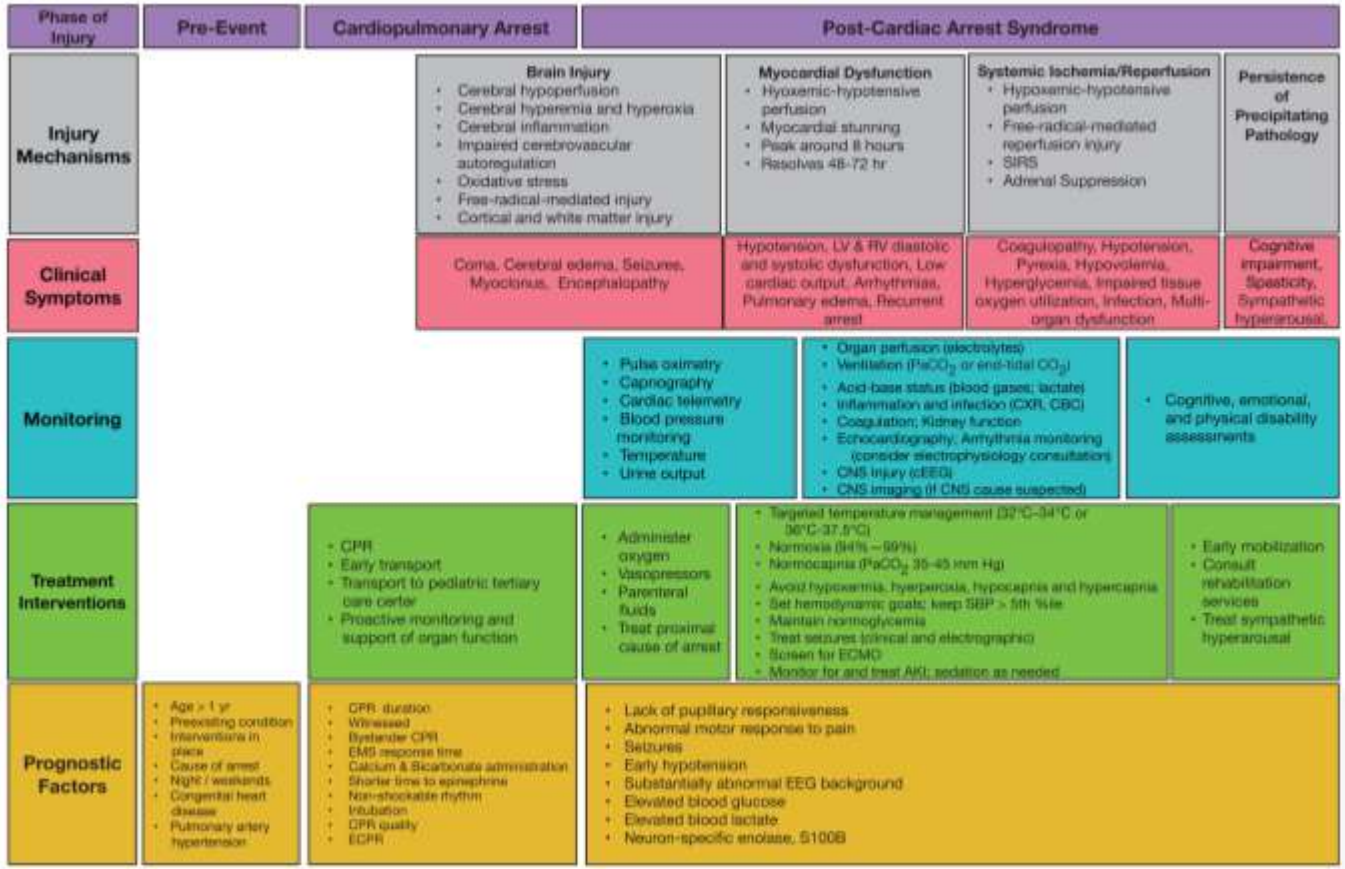
In line with the ILCOR 2019 COSTR update on targeted temperature management (TTM) in children after ROSC,[697] TTM should be used for children who achieve ROSC (appendix RR 36.3). Although potentially of benefit, lower goals for TTM (e.g. 34 °C) demand appropriate systems of paediatric neurocritical care and should only be used in settings where these are in place. Whether certain temperature goals are more appropriate for certain subgroups is not supported by evidence and thus at the discretion of the attending team. This is also the case for the duration of TTM (24 to 72 h).

Prognostication

An ILCOR 2020 EvUp evaluated the role of EEG in neuroprognostication.[143] Although EEG background patterns seem associated with neurological outcomes, the authors concluded that neither the presence or absence of any single factor predicts with high accuracy survival or survival with favourable neurological outcome. Biological markers measured within the first 24 h such as elevated blood lactate, or blood pH, or base excess may be indicative, but cut-off values remain unknown. Neuroimaging using CT, EEG, or biological markers may be promising in the future (appendix RR 36.6).

Pediatric Post–Cardiac Arrest Care

A Scientific Statement From the American Heart Association



Components of Post–Cardiac Arrest Care	Check
Oxygenation and ventilation	
Measure oxygenation and target normoxemia 94%-99% (or child's normal/appropriate oxygen saturation).	☐
Measure and target $Paco_2$ appropriate to the patient's underlying condition and limit exposure to severe hypercapnia or hypocapnia.	☐
Hemodynamic monitoring	
Set specific hemodynamic goals during post–cardiac arrest care and review daily.	☐
Monitor with cardiac telemetry.	☐
Monitor arterial blood pressure.	☐
Monitor serum lactate, urine output, and central venous oxygen saturation to help guide therapies.	☐
Use parenteral fluid bolus with or without inotropes or vasopressors to maintain a systolic blood pressure greater than the fifth percentile for age and sex.	☐
Targeted temperature management (TTM)	
Measure and continuously monitor core temperature.	☐
Prevent and treat fever immediately after arrest and during rewarming.	☐
If patient is comatose apply TTM (32°C-34°C) followed by (36°C-37.5°C) or only TTM (36°C-37.5°C).	☐
Prevent shivering.	☐
Monitor blood pressure and treat hypotension during rewarming.	☐
Neuromonitoring	
If patient has encephalopathy and resources are available, monitor with continuous electroencephalogram.	☐
Treat seizures.	☐
Consider early brain imaging to diagnose treatable causes of cardiac arrest.	☐
Electrolytes and glucose	
Measure blood glucose and avoid hypoglycemia.	☐
Maintain electrolytes within normal ranges to avoid possible life-threatening arrhythmias.	☐
Sedation	
Treat with sedatives and anxiolytics.	☐
Prognosis	
Always consider multiple modalities (clinical and other) over any single predictive factor.	☐
Remember that assessments may be modified by TTM or induced hypothermia.	☐
Consider electroencephalogram in conjunction with other factors within the first 7 days after cardiac arrest.	☐
Consider neuroimaging such as magnetic resonance imaging during the first 7 days.	☐

PAEDIATRIC ADVANCED LIFE SUPPORT

EUROPEAN RESUSCITATION COUNCIL
GUIDELINES 2021

DURING CPR

- Ensure high-quality CPR: rate, depth, recoil
- Provide bag-mask ventilation with 100% oxygen (2-person approach)
- Avoid hyperventilation
- Vascular access (intravenous, intraosseous)
- Once started, give adrenaline every 3-5 min
- Flush after each drug
- Repeat amiodarone 5 mg/kg (max 150mg) after the 5th shock
- Consider an advanced airway and capnography (if competent)
- Provide continuous compressions when a tracheal tube is in place. Ventilate at a rate of 25 (infants) – 20 (1-8y) – 15 (8-12y) or 10 (>12y) per minute
- Consider stepwise escalating shock dose (max 8J/kg – max 360J) for refractory VF/pVT (≥6 shocks)

CORRECT REVERSIBLE CAUSES

- Hypoxia
- Hypovolaemia
- Hyper/hypokalaemia, -calcaemia, -magnesemia; Hypoglycaemia
- Hypothermia - hyperthermia
- Toxic agents
- Tension pneumothorax
- Tamponade (cardiac)
- Thrombosis (coronary or pulmonary)

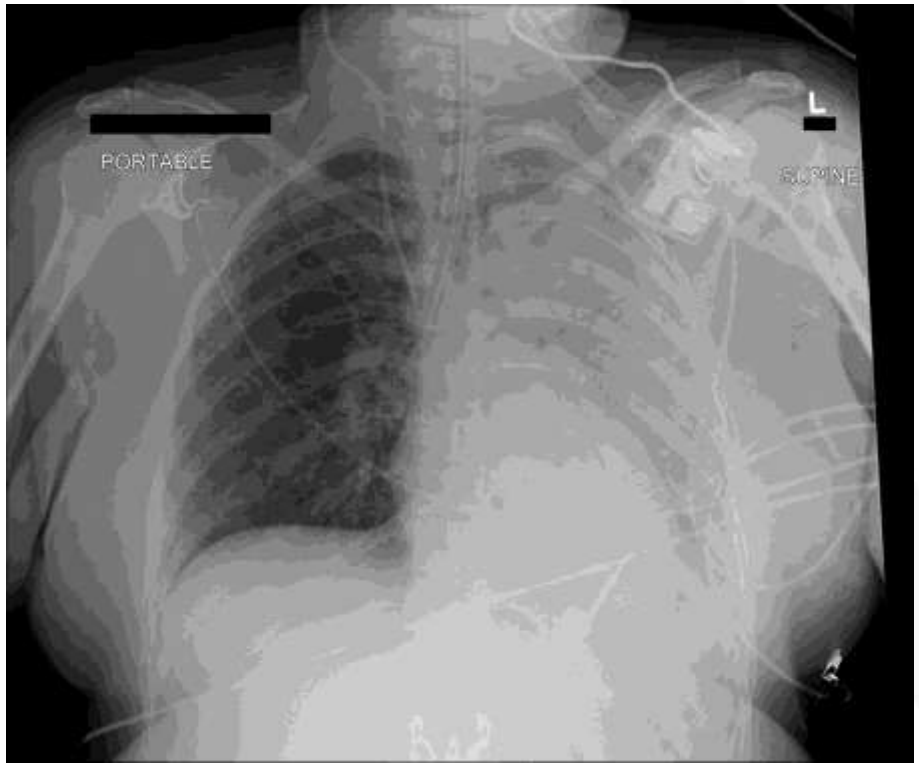
ADJUST ALGORITHM IN SPECIFIC SETTINGS (E.G. TRAUMA, E-CPR)

IMMEDIATE POST ROSC

- ABCDE approach
- Controlled oxygenation (SpO_2 94-98%) & ventilation (normocapnia)
- Avoid hypotension
- Treat precipitating causes

CORRETTA POSIZIONE TUBO ETT

Auscultazione, **EtCO2**, broncoscopia, Rx torace, ecografia POCUS



VENTILAZIONI EFFICACI

- Espansione torace
- **EtCO2**
- POCUS?

When in doubt…DOPES!!!

Effect of Out-of-Hospital Pediatric Endotracheal Intubation on Survival and Neurological Outcome

A Controlled Clinical Trial

JAMA. 2000;283:783-790

Marianne Gausche, MD
Roger J. Lewis, MD, PhD
Samuel J. Stratton, MD, MPH
Bruce E. Haynes, MD
Carol S. Gunter, BSN, MPA
Suzanne M. Goodrich, RN, MSN
Pamela D. Poore, RN
Maureen D. McCollough, MD, MPH
Deborah P. Henderson, PhD, RN
Franklin D. Pratt, MD
James S. Seidel, MD, PhD

	No. (%) of Patients	
	BVM (n = 404)	ETI (n = 416)
Normal or no change from baseline	39 (10)	33 (8)
No change from baseline status	33 (8)	25 (6)
Mild disability	20 (5)	27 (6)
Moderate disability	6 (1)	7 (2)
Severe disability	10 (2)	6 (1)
Coma/vegetative	15 (4)	12 (3)
Death	281 (70)	306 (74)

*BVM indicates bag-valve-mask ventilation; ETI, endotracheal intubation. There were no significant differences in outcomes between the 2 groups.

830 OHCA, < 12 anni o 40 kg, EMS paramedici

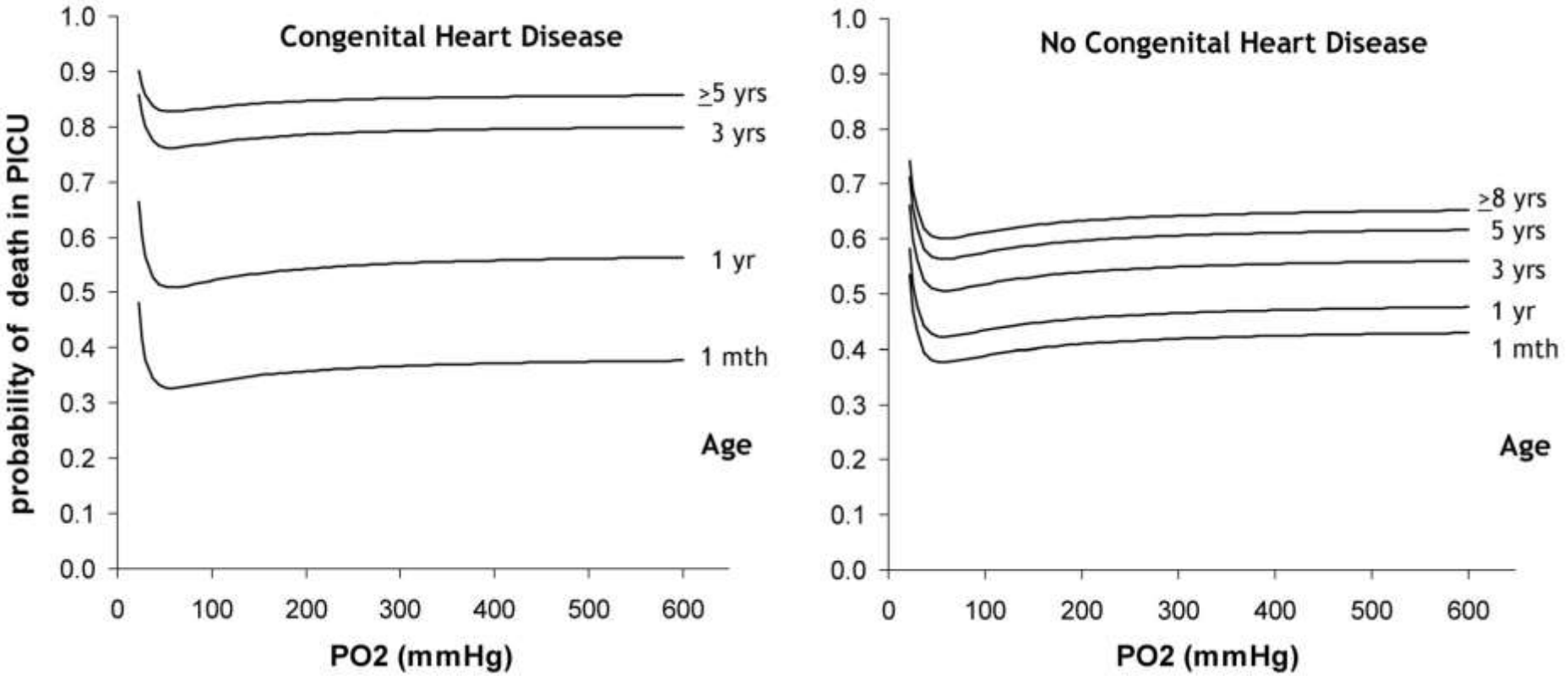
- EtCO2 come conferma di corretta intubazione 77%
- Successo intubazione 57%
- Espansione toracica BMV 83% e ETI 82%
- ETI maggiore tempo sulla scena
- BMV sovradistensione stomaco 31 vs 7%

Relationship Between Arterial Partial Oxygen Pressure After Resuscitation From Cardiac Arrest and Mortality in Children

Lee P. Ferguson, MBChB; Andrew Durward, FCP; Shane M. Tibby, MSc, MBChB

Circulation. 2012;126:335-342

PaO2 < 60 mmHg 24%, odds ratios of 1.92 PICU mortality
PaO2 > 300 mmHg 11%, odds ratio for mortality of 1.12 PICU mortality



Hyperoxia after pediatric cardiac arrest: Association with survival and neurological outcomes

Jessica A. Barreto[a,*], *Noel S. Weiss*[b], *Katie R. Nielsen*[c], *Reid Farris*[c], *Joan S. Roberts*[c]

RESUSCITATION 171 (2022) 8–14

Table 2 – Univariable and multivariable logistic regression analyses for in-hospital mortality as the outcome variable.

Variable	Died	Survived	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Hyperoxia[a]	40	49	1.4 (0.8, 2.4)	0.35	1.1 (0.6, 2.1) [b]	0.68
No hyperoxia	37	61				

[a] Defined as at least one value of PaO2 > 200 mmHg in the first 24 hours after cardiac arrest.

[b] Adjusted for duration of chest compressions, extracorporeal life support during the first 24 hours following cardiac arrest.

Hyperoxia, hypocapnia and hypercapnia as outcome factors after cardiac arrest in children☆

Jimena del Castillo[a], Jesús López-Herce[a,*], Martha Matamoros[b], Sonia Cañadas[c], Ana Rodriguez-Calvo[d], Corrado Cechetti[e], Antonio Rodriguez-Núñez[f], Angel Carrillo Álvarez[a], The Iberoamerican Pediatric Cardiac Arrest Study Network RIBEPCI[g]

Resuscitation 83 (2012) 1456–1461

In-hospital mortality according to $PaCO_2$.

In-hospital mortality (%)			
After ROSC	$PaCO_2$<30 mmHg (n = 30)	$PaCO_2$ 30–50 mmHg (n = 130)	$PaCO_2$>50 mmHg (n = 61)
	50.0	33.1	59.0
	p = 0.02		
24 h after CA	$PaCO_2$ < 30 mmHg (n = 9)	$PaCO_2$ 30–50 mmHg (n = 118)	$PaCO_2$ > 50 mmHg (n = 25)
	44.4	33.1	32.0
	p = 0.37		

Multiple logistic regression model with mortality as dependent variable.

Variable	OR	95% CI	p Value
Cause of arrest: respiratory illness	0.28	0.11–0.70	0.007
Initial type of arrest: cardiac	0.63	0.25–1.61	0.33
Place of arrest: PICU	1.45	0.72–2.92	0.30
Initial rhythm: VF or PVT	0.05	0.005–0.399	0.005
Duration of CPR > 20 min	1.88	0.71–5.01	0.21
$PaCO_2$ > 50 mmHg after ROSC	3.27	1.62–6.61	0.001
$PaCO_2$ < 30 mmHg after ROSC	2.71	1.04–7.05	0.04

Abbreviations: CI, confidence interval; OR, odds ratio; $PaCO_2$, arterial partial carbon dioxide pressure; PICU, pediatric intensive care unit; PVT, pulseless ventricular tachycardia; VF, ventricular fibrillation; CPR, cardiopulmonary resuscitation.

Table 1 – Normal values for age: respiratory rate.

Respiratory rate for age	1 month	1 year	2 year	5 year	10 year
Upper limit of normal range	60	50	40	30	25
Lower limit of normal range	25	20	18	17	14

- SpO2 target 94-98%
- Normocapnia (PaCO2 35-45 mmHg)

  Oppure un valore di CO2 specifico per le condizioni del paziente (e.g. chronic respiratory failure, CHD)
- *Ventilazione protettiva? Ruolo di tecniche rescue?*

ATTENZIONE ALL'EtCO2 COME SURROGATO DELLA PaCO2

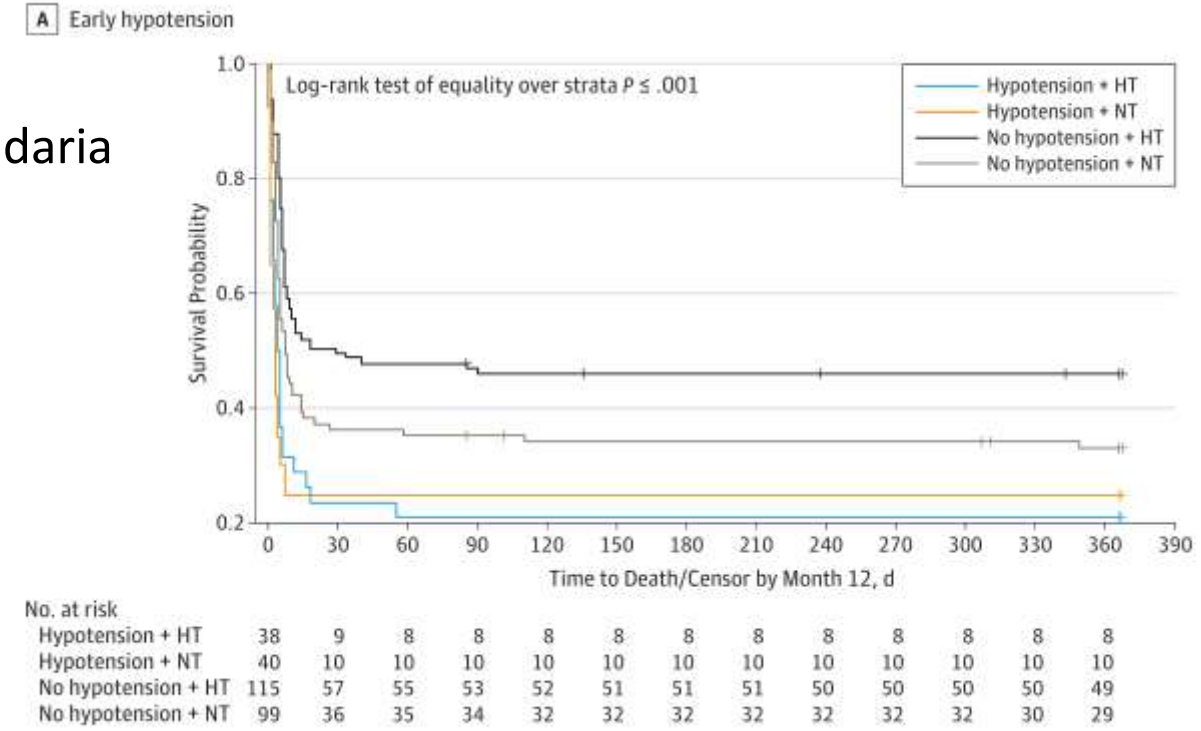
Association of Early Postresuscitation Hypotension With Survival to Discharge After Targeted Temperature Management for Pediatric Out-of-Hospital Cardiac Arrest

Secondary Analysis of a Randomized Clinical Trial

Alexis A. Topjian, MD, MSCE; Russell Telford, MAS; Richard Holubkov, PhD; Vinay M. Nadkarni, MD, MS; Robert A. Berg, MD; J. Michael Dean, MD, MBA; Frank W. Moler, MD, MS; for the Therapeutic Hypothermia After Pediatric Cardiac Arrest (THAPCA) Trial Investigators

JAMA Pediatrics February 2018 Volume 172, Number 2

Analisi secondaria
THAPCA trial
292 bambini



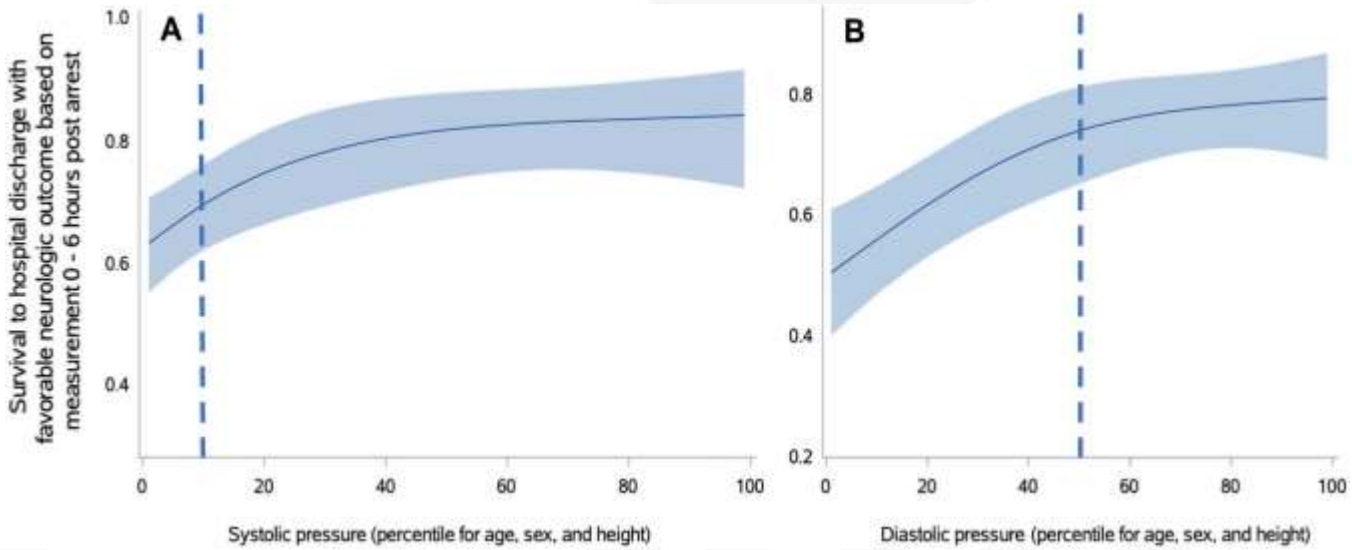
- Ipotensione precoce 26.7%
- Fattori di rischio
  - No bystander CPR
  - Causa cardiaca
  - RCP > 30 min
  - > 4 dosi adrenalina
  - Lattati di ingresso più alti
- Maggior prevalenza durante induzione e mantenimento TTM

Factor	Survival to Hospital Discharge[a]		P Value	OR (95% CI)	
	No (n = 179)	Yes (n = 113)		Unadjusted	Adjusted
Any hypotension					
0-6 h	58 (32.4)	20 (17.7)	.006[b]	0.45 (0.25-0.80)	0.39 (0.20-0.74)
0-72 h	99 (55.3)	62 (54.9)	.94[b]	0.98 (0.61-1.58)	NA

Characteristic	Overall (N = 292)	Any Hypotension at 0-72 h		P Value
		No (n = 131)	Yes (n = 161)	
Minimum measured lactate level, median (IQR), mmol/L [No. of participants]	1.2 (0.8-2.1) [285]	1.2 (0.8-1.7) [128]	1.2 (0.8-2.6) [157]	.16[c]
No medications, No. (%)	78 (26.7)	50 (38.2)	28 (17.4)	<.001[c]
No. of vasoactive agents administered, No. (%)				
0	98 (33.6)	59 (45.0)	39 (24.2)	<.001[c]
1	77 (26.4)	38 (29.0)	39 (24.2)	
2	100 (34.2)	28 (21.4)	72 (44.7)	
3	17 (5.8)	6 (4.6)	11 (6.8)	
Milrinone administered, No. (%)	36 (12.3)	11 (8.4)	25 (15.5)	.07[c]
Corticosteroids administered, No. (%)	57 (19.5)	16 (12.2)	41 (25.5)	.004[c]
Vasopressin administered, No. (%)	68 (23.3)	26 (19.8)	42 (26.1)	.21[c]

Identification of post-cardiac arrest blood pressure thresholds associated with outcomes in children: an ICU-Resuscitation study

Monique M. Gardner[1*], David A. Hehir[1], Ron W. Reeder[2], Tageldin Ahmed[3], Michael J. Bell[4], Robert A. Berg[1], Robert Bishop[5], Matthew Bochkoris[6], Candice Burns[7], Joseph A. Carcillo[6], Todd C. Carpenter[5], J. Michael Dean[2], J. Wesley Diddle[1], Myke Federman[8], Richard Fernandez[9], Ericka L. Fink[6], Deborah Franzon[10], Aisha H. Frazier[11], Stuart H. Friess[12], Kathryn Graham[1], Mark Hall[9], Monica L. Harding[2], Christopher M. Horvat[6], Leanna L. Huard[8], Tensing Maa[9], Arushi Manga[12], Patrick S. McQuillen[10], Kathleen L. Meert[3], Ryan W. Morgan[1], Peter M. Mourani[13], Vinay M. Nadkarni[1], Maryam Y. Naim[1], Daniel Notterman[14], Murray M. Pollack[4], Anil Sapru[8], Carleen Schneiter[5], Matthew P. Sharron[4], Neeraj Srivastava[8], Bradley Tilford[3], Shirley Viteri[15], David Wessel[4], Heather A. Wolfe[1], Andrew R. Yates[9], Athena F. Zuppa[1], Robert M. Sutton[1] and Alexis A. Topjian[1]



1129 eventi dallo studio ICU-RESUS
693 eventi 0-6 h, 636 eventi 6-24 h

Table 3 Multivariable associations between systolic and diastolic pressure 0–6 h post arrest and survival

		Survival to hospital discharge with favorable neurologic outcome[a]		Survival to hospital discharge	
	Overall (*N* = 693)	Relative risk (95% CI)	*P* value	Relative risk (95% CI)	*P* value
Post-arrest systolic threshold (0–6 h)[c]			< .001		< .001
Above (> 10th percentile)	352 (50.8%)	1.22 (1.10, 1.35)		1.21 (1.10, 1.33)	
Below—inclusive (≤ 10th percentile)	341 (49.2%)	Reference		Reference	
Post-arrest diastolic threshold (0–6 h)[c]			< .001		< .001
Above (> 50th percentile)	346 (49.9%)	1.27 (1.15, 1.40)		1.23 (1.12, 1.34)	
Below—inclusive (≤ 50th percentile)	347 (50.1%)	Reference		Reference	

Table 2 – Normal values for age: heart rate.

Heart rate for age	1 month	1 year	2 year	5 year	10 year
Upper limit of normal range	180	170	160	140	120
Lower limit of normal range	110	100	90	70	60

Table 3 – Normal values for age: systolic and mean arterial blood pressure (MAP). Fifth (p5) and fiftieth (p50) percentile for age.

Blood pressure for age	1 month	1 year	5 year	10 year
p50 for systolic BP	75	95	100	110
p5 for systolic BP	50	70	75	80
p50 for MAP	55	70	75	75
p5 for MAP	40	50	55	55

- Monitoraggio continuo pressione arteriosa
- Controllo precoce pressione arteriosa
  - Evitare SAP < 5° percentile
  - SAP > 10° e DAP > 50° percentile
- *Associazione vs causalità? Goal-directed hemodynamic? Gittata cardiaca? Farmaci?*

SEDAZIONE & ANALGESIA

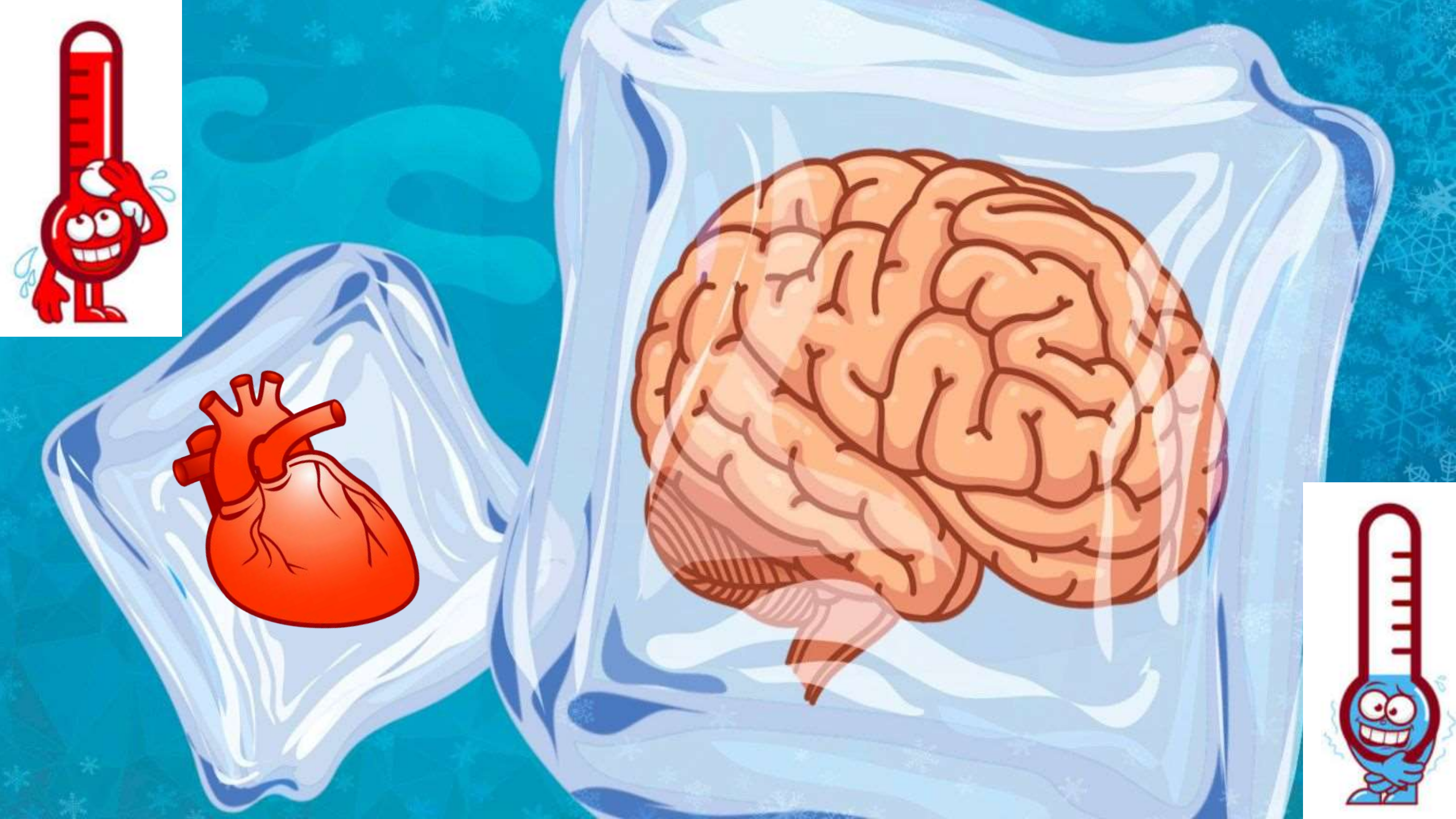
- Dolore e stress aumentano il $CMRO_2$, il volume ematico cerebrale e la ICP
- NMBA utili per controllare crisi convulsive tonico-cloniche, brividi (soprattutto in corso di ipotermia), asincronie con il ventilatore
- Attenzione alla farmacocinentica durante TTM, rischio di mascherare la neurologia (utilità monitoraggio?)

CONTROLLO DELLA GLICEMIA

- Nessuna evidenza a favore del controllo stretto della glicemia (maggior rischio di ipoglicemia). Mantenere normoglicemia, meglio tollerata una lieve iperglicemia (< 160-180 mg/dl)
- Evitare l'ipoglicemia (< 45 mg/dl nel neonato e < 60 mg/dl nel bambino)

MONITORAGGIO E TRATTAMENTO DELLO STATO CONVULSIVO

- Presente nel 10-50% dei pazienti
- Circa la metà stato epilettico non convulsivo
- Monitoraggio EEG appena disponibile, proseguire per 24-48 h o comunque almeno fino 24 h di normotermia in pazienti trattati con ipotermia terapeutica
- Se evidenza EEG di stato epilettico iniziare terapia anticomiziale
- Nessuna evidenza a favore di terapia profilattica

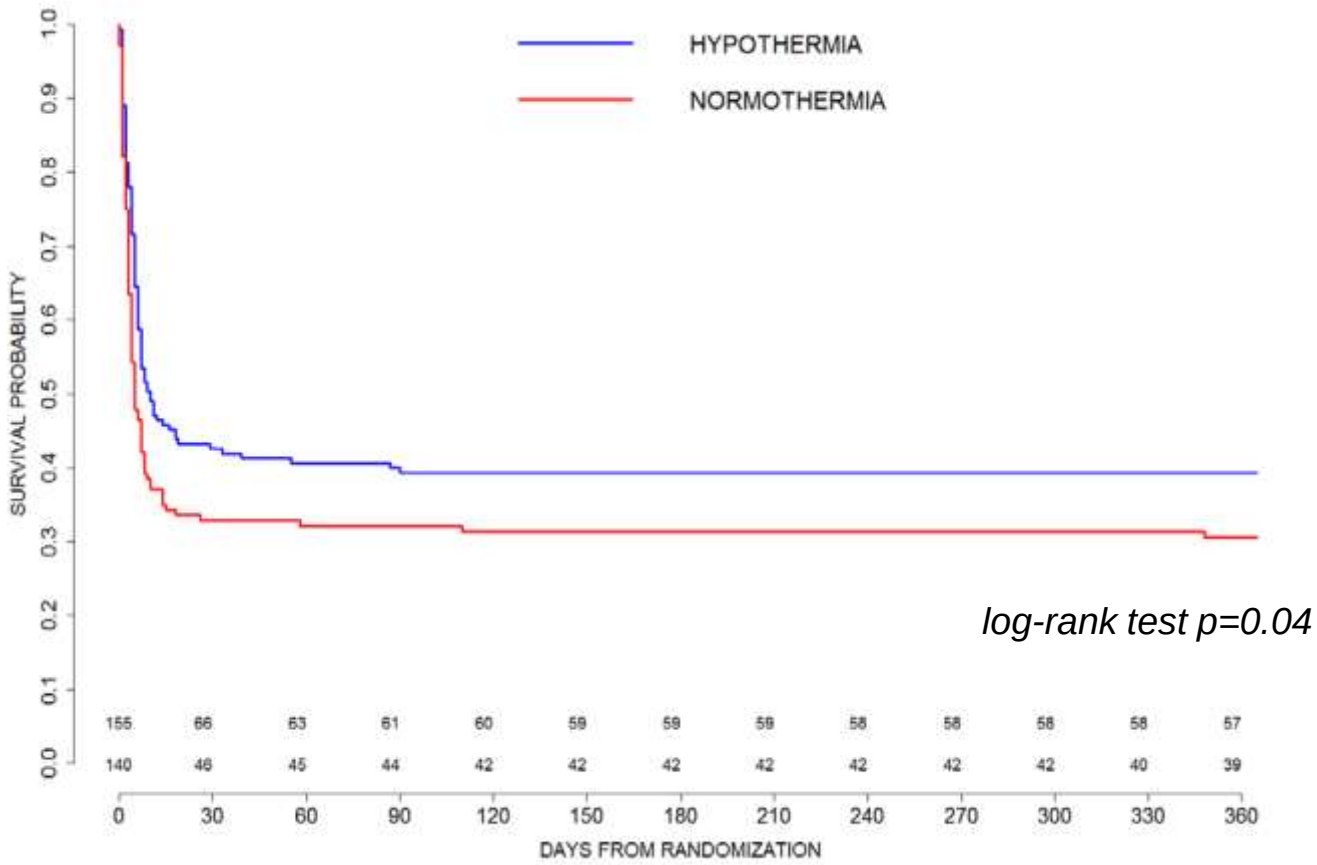


The NEW ENGLAND JOURNAL of MEDICINE

Therapeutic Hypothermia after Out-of-Hospital Cardiac Arrest in Children

THAPCA Trial Investigators

N Engl J Med 2015;372:1898-908.



log-rank test p=0.04

Nord America, Canada e UK, 295 pazienti

- 48 ore - 18 anni
- OHCA
- RCP > 2 min
- Dipendente da VM in ICU

OUTCOME

1. **Sopravvivenza con buon outcome neurologico a 12 mesi**
2. Sopravvivenza a 12 mesi e cambiamento della funzione neurocognitiva
3. Score neurocognitivi/psicologici
4. Safety del trattamento

Table 2. Primary and Secondary Outcomes.*

Outcome	Hypothermia Group	Normothermia Group	Risk Difference	Relative Likelihood (95% CI)	P Value
	no./total no. (%)		*percentage points (95% CI)*		
Primary outcome					
Alive with VABS-II score ≥70 at 1 yr	27/138 (20)	15/122 (12)	7.3 (−1.5 to 16.1)	1.54 (0.86 to 2.76)	0.14†
Detailed supportive analysis					0.14‡
Death	87/138 (63)	88/122 (72)			
Disability					
Profound§	16/138 (12)	11/122 (9)			
Moderate-to-severe¶	8/138 (6)	8/122 (7)			
Good functional status‖	27/138 (20)	15/122 (12)			
Secondary outcomes					
Alive at 1 yr	57/151 (38)	39/136 (29)	9.1 (−1.8 to 19.9)	1.29 (0.93 to 1.79)	0.13†
1-yr change in VABS-II score from baseline					0.13**
Death	94/151 (62)	97/134 (72)			
Lowest possible VABS-II score	6/151 (4)	1/134 (1)			
Decrease in VABS-II score					
>30 points	19/151 (13)	15/134 (11)			
16–30 points	11/151 (7)	4/134 (3)			
≤15 points or improved	21/151 (14)	17/134 (13)			

The target sample size was calculated on the basis of an absolute effect size of 15 to 20%, with an estimated primary outcome rate of 15 to 35% in the normothermia group.

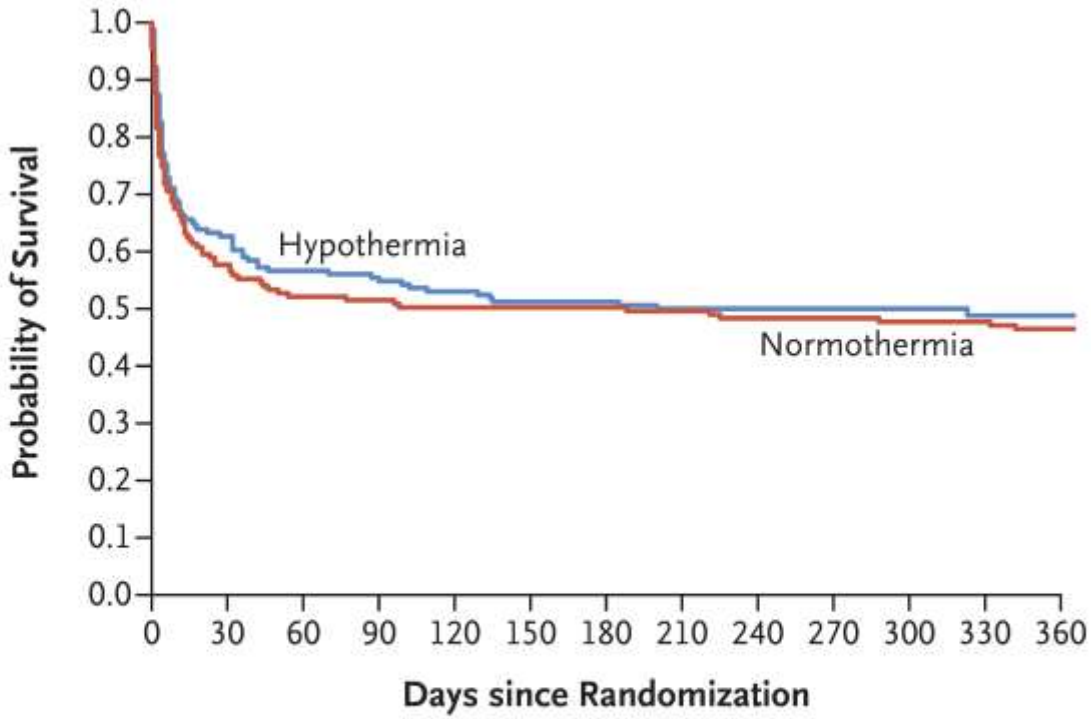
Moler et al. NEJM 2015

The NEW ENGLAND JOURNAL of MEDICINE

Therapeutic Hypothermia after In-Hospital Cardiac Arrest in Children

THAPCA Trial Investigators

N Engl J Med 2017;376:318-29.



No. at Risk													
Hypothermia	166	104	94	92	88	85	85	83	83	83	83	81	81
Normothermia	163	94	84	82	80	80	80	79	77	77	76	76	74

Nord America, Canada e UK, 329 pazienti

- 48 ore -18 anni
- IHCA
- RCP > 2 min
- Dipendente da VM in ICU

OUTCOME

1. **Sopravvivenza con buon outcome neurologico a 12 mesi**
2. Sopravvivenza a 12 mesi e cambiamento della funzione neurocognitiva
3. Score neurocognitivi/psicologici
4. Safety del trattamento

Table 2. Primary and Secondary Outcomes.*

Outcome	Hypothermia Group	Normothermia Group	Risk Difference	Relative Risk (95% CI)	P Value
	no./total no. (%)		*percentage points (95% CI)*		
Primary outcome					
Alive with VABS-II score ≥70 at 1 yr	48/133 (36)	48/124 (39)	−2.6 (−14.5 to 9.2)	0.92 (0.67 to 1.27)	0.63†
Detailed supportive analysis‡					0.85§
Death	65/133 (49)	67/124 (54)			
VABS-II score					
<45 or lowest possible	2/133 (2)	0/124			
45–69	18/133 (14)	9/124 (7)			
≥70	48/133 (36)	48/124 (39)			
Secondary outcomes					
Alive at 1 yr	81/166 (49)	74/161 (46)	2.8 (−8.0 to 13.7)	1.07 (0.85 to 1.34)	0.56†
Change in VABS-II score from baseline to 1 yr¶					0.70‖
Death	85/164 (52)	87/153 (57)			
Lowest possible VABS-II score	1/164 (1)	0/153			
Decrease in VABS-II score from baseline					
>30 points	12/164 (7)	8/153 (5)			
16–30 points	17/164 (10)	14/153 (9)			
≤15 points or improved	49/164 (30)	44/153 (29)			

STUDIO INTERROTTO PER FUTILITÀ
(nessuna evidenza di trend all'analisi ad interim per outcome 1° e 2°)

Moler et al. NEJM 2017

ERC–ESICM GUIDELINES

TEMPERATURE CONTROL AFTER CARDIAC ARREST IN ADULTS

EUROPEAN RESUSCITATION COUNCIL

RECOMMENDATIONS

We recommend continuous monitoring of core temperature in patients who remain comatose after ROSC from cardiac arrest.

GOOD PRACTICE STATEMENT

Temperature control can be achieved by exposing the patient, using anti-pyretic drugs, or if this is insufficient, by using a cooling device with a target temperature of 37.5 °C.

GOOD PRACTICE STATEMENT

We recommend actively preventing fever (defined as a temperature > 37.7 °C) in post-cardiac arrest patients who remain comatose.

WEAK RECOMMENDATION

★★☆☆ LOW CERTAINTY EVIDENCE

There is currently insufficient evidence to recommend for or against temperature control at 32–36 °C in sub-populations of cardiac arrest patients or using early cooling, and future research may help elucidate this. We recommend not actively rewarming comatose patients with mild hypothermia after ROSC to achieve normothermia.

GOOD PRACTICE STATEMENT

We recommend actively preventing fever for at least 72 hours in post-cardiac arrest patients who remain comatose.

GOOD PRACTICE STATEMENT

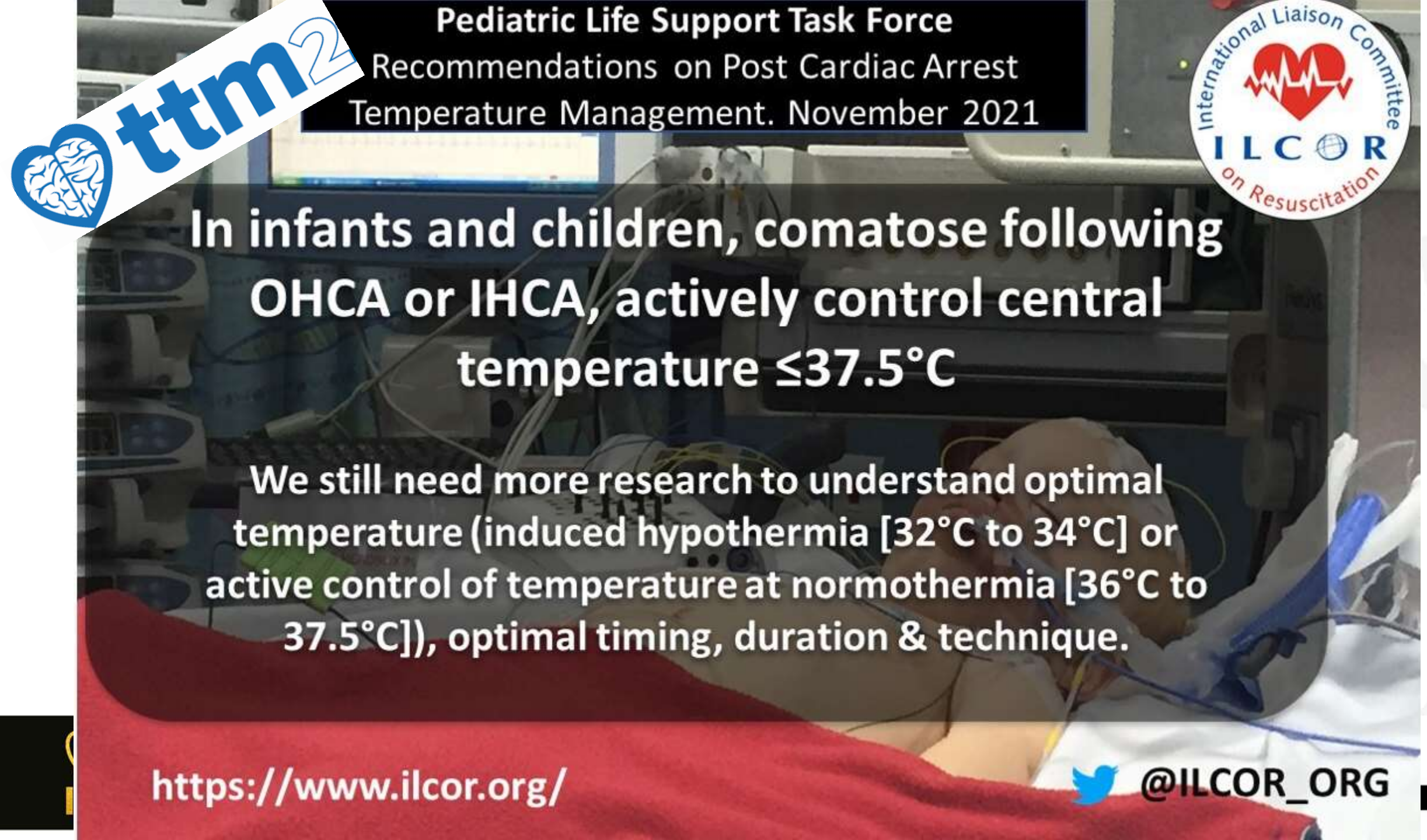
We recommend not using prehospital cooling with rapid infusion of large volumes of cold IV fluid immediately after ROSC.

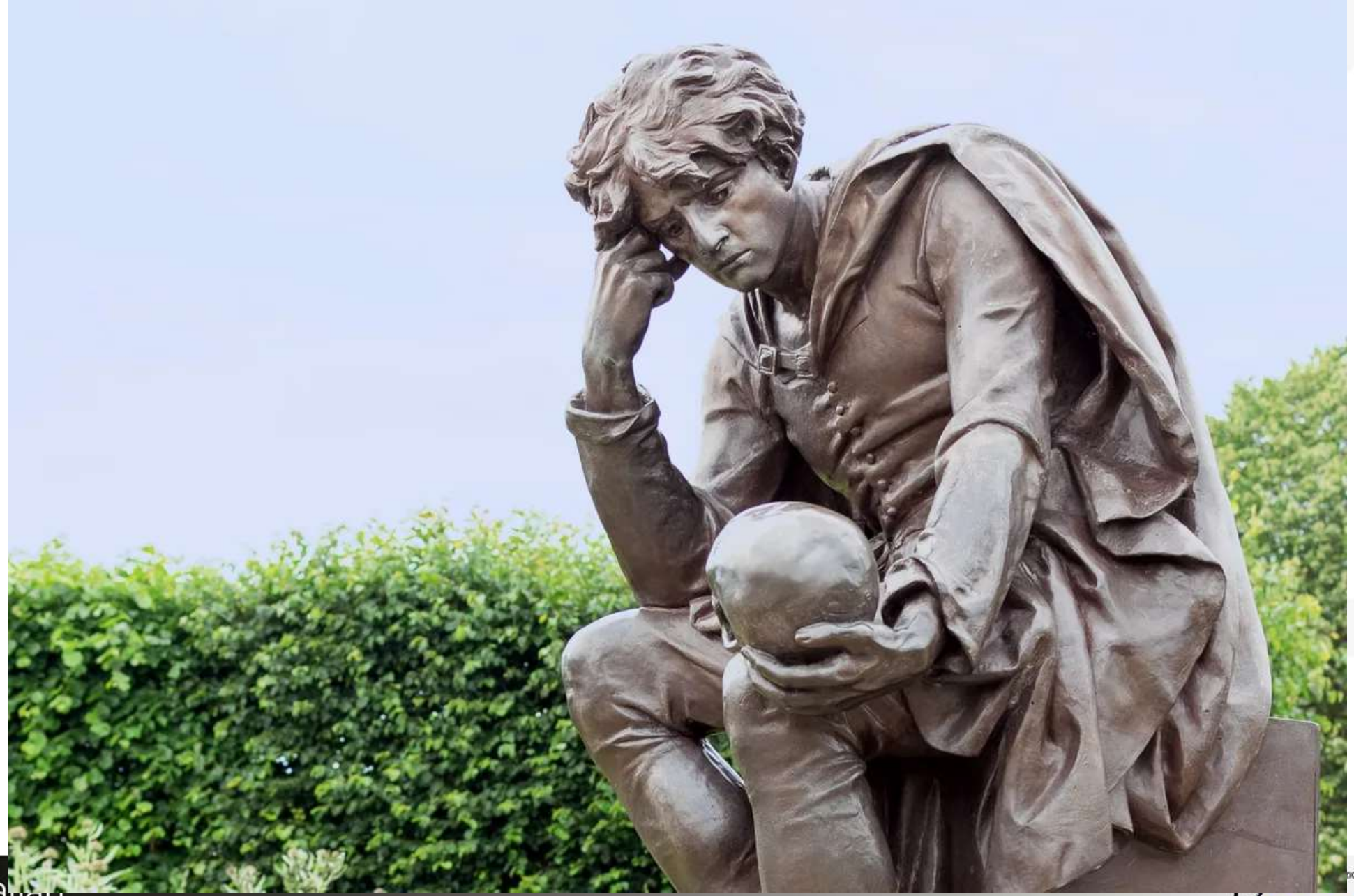
STRONG RECOMMENDATION

★★★☆ MODERATE CERTAINTY EVIDENCE

Nolan JP et al. Resuscitation 2022. DOI: 10.1016/j.resuscitation.2022.01.009

INFOGRAPHIC BY TOMMASO SCQUIZZATO @tscquizzato


ttm2
Pediatric Life Support Task Force
Recommendations on Post Cardiac Arrest
Temperature Management. November 2021
International Liaison Committee
ILCOR
on Resuscitation
In infants and children, comatose following OHCA or IHCA, actively control central temperature ≤37.5°C
We still need more research to understand optimal temperature (induced hypothermia [32°C to 34°C] or active control of temperature at normothermia [36°C to 37.5°C]), optimal timing, duration & technique.
https://www.ilcor.org/
@ILCOR_ORG



Phase	Factor*	Outcome Type	Survival	Arrest Location
Prearrest	Younger age:			
	Fink et al[13]	Survival to hospital discharge	Decreased	OHCA
	Goto et al[188]	1-mo survival		
	Older age[21,189]	Survival to hospital discharge	Decreased	IHCA
	Preexisting condition: Genetic/metabolic[152] Acute renal failure[21,87,190] Sepsis[21,191] Hepatic insufficiency[21] Hematologic/oncological/immunological[152,191,192] Baseline neurological abnormality[21,192] Congenital heart disease[21]	Survival to hospital discharge	Decreased	IHCA
	Preexisting lung/airway disease[18]	Survival to hospital discharge	Increased	OHCA
	Postoperative patient[152] Post–cardiac surgery[193]	Survival to hospital discharge	Increased	IHCA
	Intervention in place: Endotracheal tube[152,190] Vasopressor infusion[87,191,192]	Survival to hospital discharge	Decreased	IHCA
	Cause of arrest:			
	SIDS[194]	1-y survival	Decreased	OHCA
	Trauma[193]	Survival to hospital discharge	Decreased	IHCA
	Drowning[12,18]	Survival to hospital discharge	Increased	OHCA
	Asthma[21]	Survival to hospital discharge	Increased	IHCA
	Day and time of arrest:			
	Nights[195]	Survival to hospital discharge	Decreased	IHCA
	Nights[196]	1-mo survival	Decreased	OHCA
	Weekends:			
	Meert et al[194]	1-y survival	Decreased	OHCA
	Kitamura et al[196]	1-mo survival		
	Public-access defibrillation[197]	1-mo survival	Increased	OHCA
	Shorter EMS response time[188]	1-mo survival	Increased	OHCA

Intra-arrest	Witnessed status:			
	Goto et al[188]	1-mo survival	Increased	OHCA
	Fink et al[13]	Survival to hospital discharge		
	Meert et al[194]	1-y survival		
	Andersen et al[198]	Survival to hospital discharge		IHCA
	Arrest rhythm VF/pVT:			
	Tijssen et al[12]	Survival to hospital discharge	Increased	OHCA
	Kitamura et al[199]	1-mo survival		
	Goto et al[200]			
	Initial VF/pVT vs initial non-VF/VT[190,201]: PEA vs asystole[198] Bradycardia[190]	Survival to hospital discharge	Increased	IHCA
	PEA vs asystole[188]	Survival to hospital discharge	Increased	OHCA
	Asystole[13] PEA[12]	Survival to hospital discharge	Decreased	OHCA
	Subsequent VF/pVT vs primary VF/pVT[191] Subsequent VF/pVT vs primary non-VF/pVT[191]	Survival to hospital discharge	Decreased	IHCA
	Subsequent VF/pVT vs sustained non-VF/pVT[188]	1-mo favorable neurological survival	Increased	OHCA

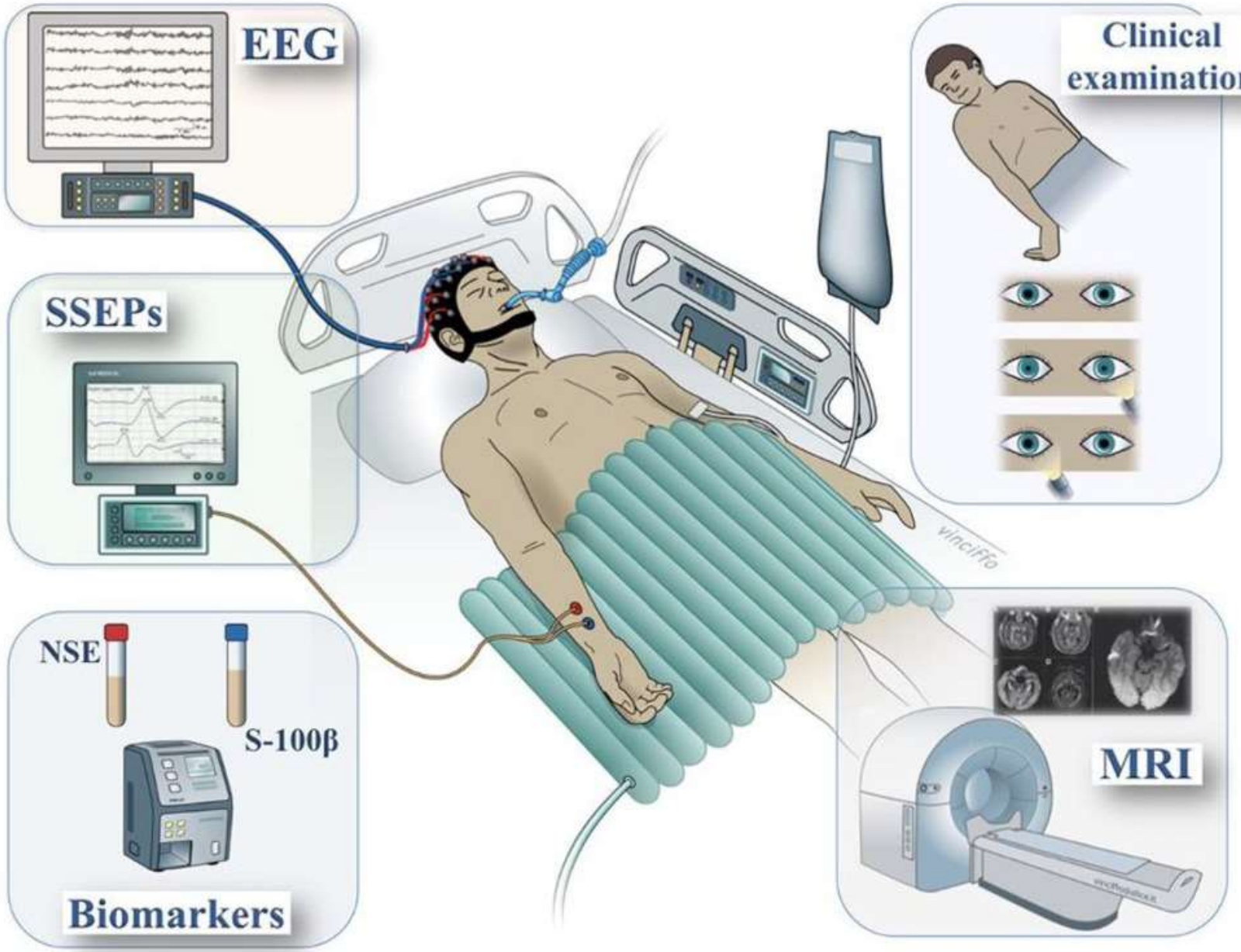
Phase	Factor*	Outcome Type	Survival	Arrest Location
Intra-arrest (Continued)	Shorter time to shock for subsequent VF/VT[188]	1-mo favorable neurological survival	Increased	OHCA
	CPR with ventilation vs chest compression–only CPR:			
	Infants[202]	Survival to hospital discharge	Increased	OHCA
	>1 y of age[202,203]	1-mo favorable neurological survival or survival to hospital discharge	No difference	
	Bystander CPR[200]	1-mo survival	Increased	OHCA
	Dispatcher-assisted CPR[200]	1-mo survival	Increased	OHCA
	Less frequent epinephrine administration[204]	Survival to hospital discharge	Increased	IHCA
	Shorter time to epinephrine[198]	Survival to hospital discharge	Increased	IHCA
	Use of ECPR[190]	Survival to hospital discharge	Increased	IHCA
	Shorter EMS scene time[12]	Survival to hospital discharge	Increased	OHCA
	Diastolic blood pressure ≥25 mm Hg in infants, ≥30 mm Hg in children during CPR[205]	Survival to hospital discharge	Increased	IHCA
	AHA-compliant CPR depth (>1 y) ≥51 mm[206]	Survival to hospital discharge	Increased	IHCA
	Drugs administered during CPR: Calcium[87,152] Sodium bicarbonate[152,190] Epinephrine[190] Atropine[18] Epinephrine[18,188]	Survival to hospital discharge	Decreased	IHCA
	Longer duration of CPR			
	Goto[188]	1-mo survival	Decreased	OHCA
	López-Herce et al[207]	1-y survival		OHCA
	Meert et al[194]			
	Del Castillo et al[192]	Survival to hospital discharge		IHCA
	Matos et al[193]			
	Endotracheal intubation during CPR[208]	Survival to hospital discharge	Decreased	IHCA

Neurological Prognostication in Children After Cardiac Arrest

Alyssa E. Smith, MD [a, *], Stuart H. Friess, MD [b]

Pediatric Neurology 108 (2020) 13–22

Modality	Reference	Predictors of Poor Outcomes	Study Type, N	Poor Outcome Measure	Timeframe of Outcome	Predictive Value or Association With Outcome
Exam	Bratton et al.[1]	No purposeful movements at 24 hours	Retrospective, 44 children	Severe disability or death	6 months	PPV 100%
	Mandel et al.[2]	Absence of spontaneous respirations at 24 hours, GCS <5 at 24 hours, absence of pupil reactivity at 24 hours	Prospective, 42 children	PCPC 4-6	3 years	PPV 100%, 100%, 100% respectively
	Carter et al.[3]	Absence of pupil reactivity at 2 days	Prospective, 36 children	GOS 1-3	5 years	PPV 50%
	Abend et al.[4]	Absence of pupil reactivity at 24 hours	Prospective, 35 children	PCPC 4-6	Hospital discharge	PPV 100%
SEP	Zandbergen et al.[5]	No early cortical SEP within 1 week of ROSC	Systematic review	PVS or death	N/A	+LR 12
	Carter et al.[6]	Bilateral absent N20	Prospective, 105 children	GOS 1-3	5 years	PPV 91%
	Carter et al.[3]	Bilateral absent N20	Prospective, 36 children	GOS 1-3	5 years	Specificity 100%
EEG	Nishisaki et al.[7]	Discontinuous/isoelectric	Retrospective, 33 children	Change in PCPC >1 or death	Hospital discharge	PPV 90%
	Kessler et al.[8]	Unreactive and continuous or discontinuous/lack of cerebral activity	Prospective, 35 children	PCPC 4-6	PICU discharge	PPV 91%
	Topjian et al.[9]	Status epilepticus	Prospective, 200 children	Worsened PCPC score from baseline or death	PICU discharge	OR 17.3
	Ostendorf et al.[10]	Early seizures, myoclonic status epilepticus, burst suppression, or suppression	Retrospective, 73 children	PCPC 4-6 or change of PCPC by > 1 from baseline	Hospital discharge	$P = 0.05$, $P = 0.17$, PPV 100% respectively
	Topjian et al.[11]	Discontinuous/burst suppression, voltage attenuation	Retrospective, 128 children	PCPC 3-6 or change of PCPC by > 1 from baseline	Hospital discharge	PPV 82%
	Fung et al.[12]	Model of EEG background, stage 2 sleep, variability, reactivity	Prospective, 89 children	PCPC 4-6	PICU discharge	PPV 86%
Imaging	Dubowitz et al.[13]	MRI T2: focal or generalized hyperintensity, abnormal basal ganglia, abnormal cortex	Retrospective, 22 children	CPC 3-5	Undefined	PPV 100%, 100%, 100% respectively
	Christophe et al.[14]	Abnormal MRI	Retrospective, 40 children	Developmental outcomes	1 month	PPV 82%
	Rafaat et al.[15]	Abnormal repeat HCT	Retrospective, 101 children	GOS 1-2	6 months	96% (23/24 patients)
	Oualha et al.[16]	Abnormal MRI DWI/ADC, cortical edema, basal ganglia edema, cerebellar edema	Retrospective, 20 children	PCPC 4-6	Undefined	PPV 53%, $P = 0.02$, $P = 0.0005$, $P = 0.05$, respectively
	Fink et al.[17]	MRI T2: basal ganglia injury	Retrospective, 28 children	GOS 1-3	Hospital discharge	PPV 90%
	Starling et al.[18]	HCT less than 24 hours with diffuse loss of GWD, basilar cistern effacement, sulcal effacement	Retrospective, 78 children	PCPC 4-6 or change from baseline ≥1	Hospital discharge	PPV 91%, 93%, 100% respectively
	Manchester et al.[19]	Global decrease MRI ADC	Retrospective, 14 children	PCPC 4-6	Hospital discharge	$P = 0.02$
	Yacoub et al.[20]	Global MRI ADC threshold	Retrospective, 26 children	PCPC 3-6 or worsening from baseline	6 months	PPV 100%


EEG
Clinical examination
SSEPs
NSE
S-100β
Biomarkers
MRI

NEUROPROGNOSI

- Non esiste un singolo parametro con cut-off sufficientemente sensibile e/o specifico che possa essere usato per definire la prognosi e/o la futilità dei trattamenti

- **Valutazione multimodale**
  Indispensabile la collaborazione con neurologi/neurofisiologi/tecnici di neurofisiopatologia esperti

- Scarsità di dati pediatrici

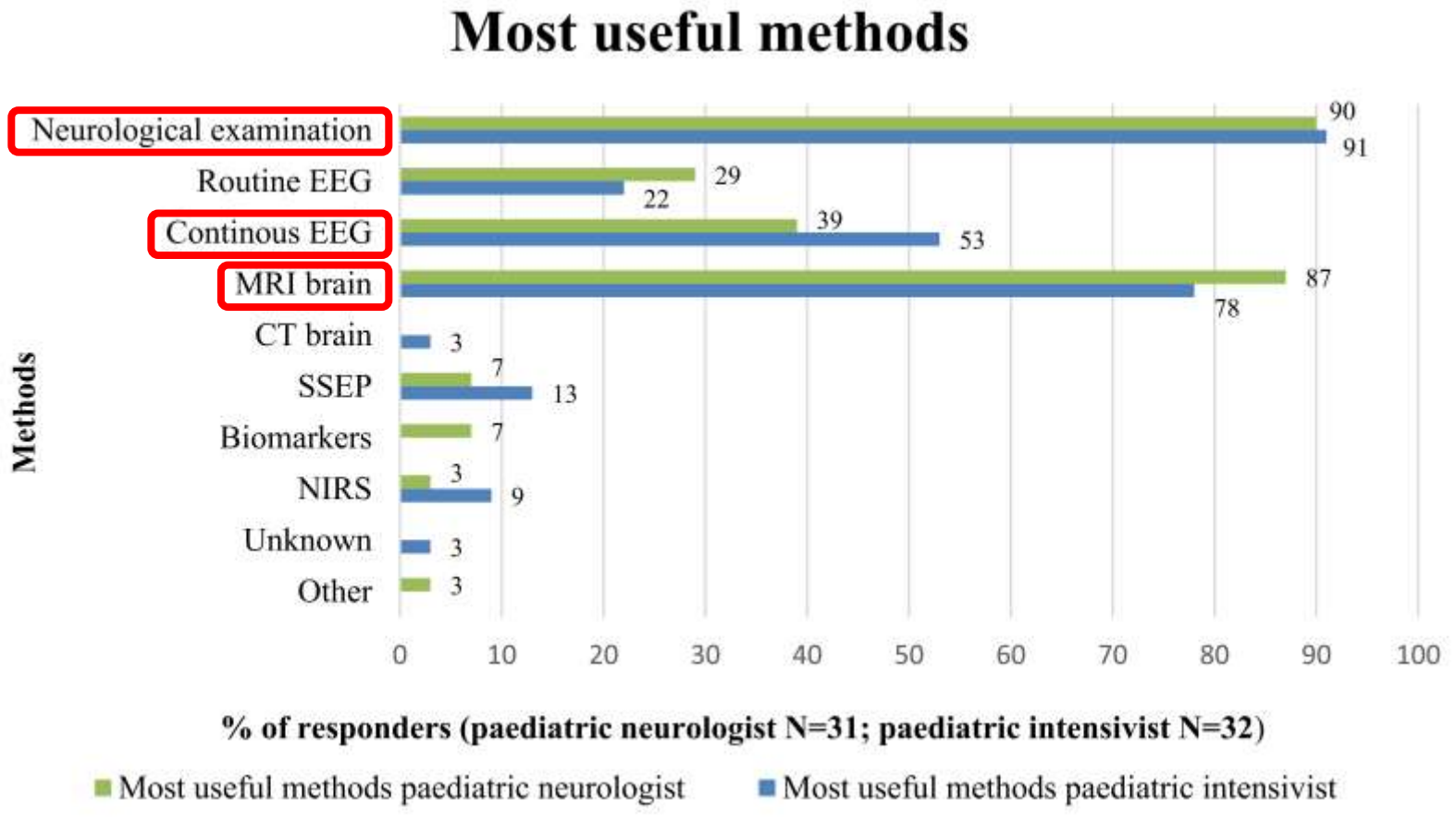
QUANDO?

- Almeno 72h dal ROSC
- In pazienti trattati con TTM, dopo 72 h di normotermia (operativamente dopo 4-5 giorni dall'evento)

The current practice regarding neuro-prognostication for comatose children after cardiac arrest differs between and within European PICUs: A survey

Maayke Hunfeld [a, b, *], Marlie A.C. Muusers [a], Coriene E. Catsman [a], Jimena del Castillo [c], Dick Tibboel [b], Corinne M.P. Buysse [b]

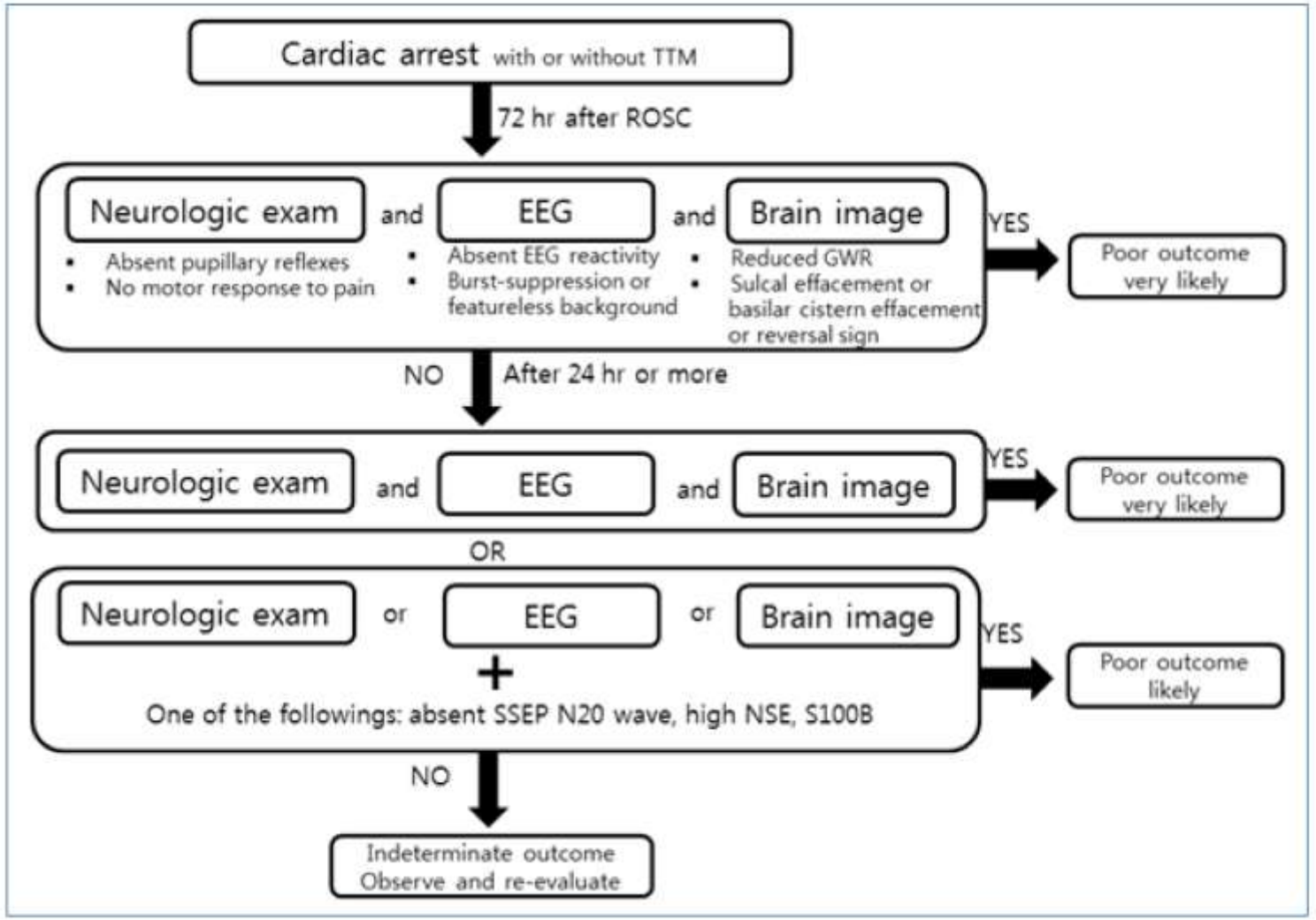
European Journal of Paediatric Neurology 28 (2020) 44–51



How can neurological outcomes be predicted in comatose pediatric patients after out-of-hospital cardiac arrest?

Hyo Jeong Kim, MD, PhD

CEP Vol. 63, No. 5, 164-170, 2020
https://doi.org/10.3345/kjp.2019.00941



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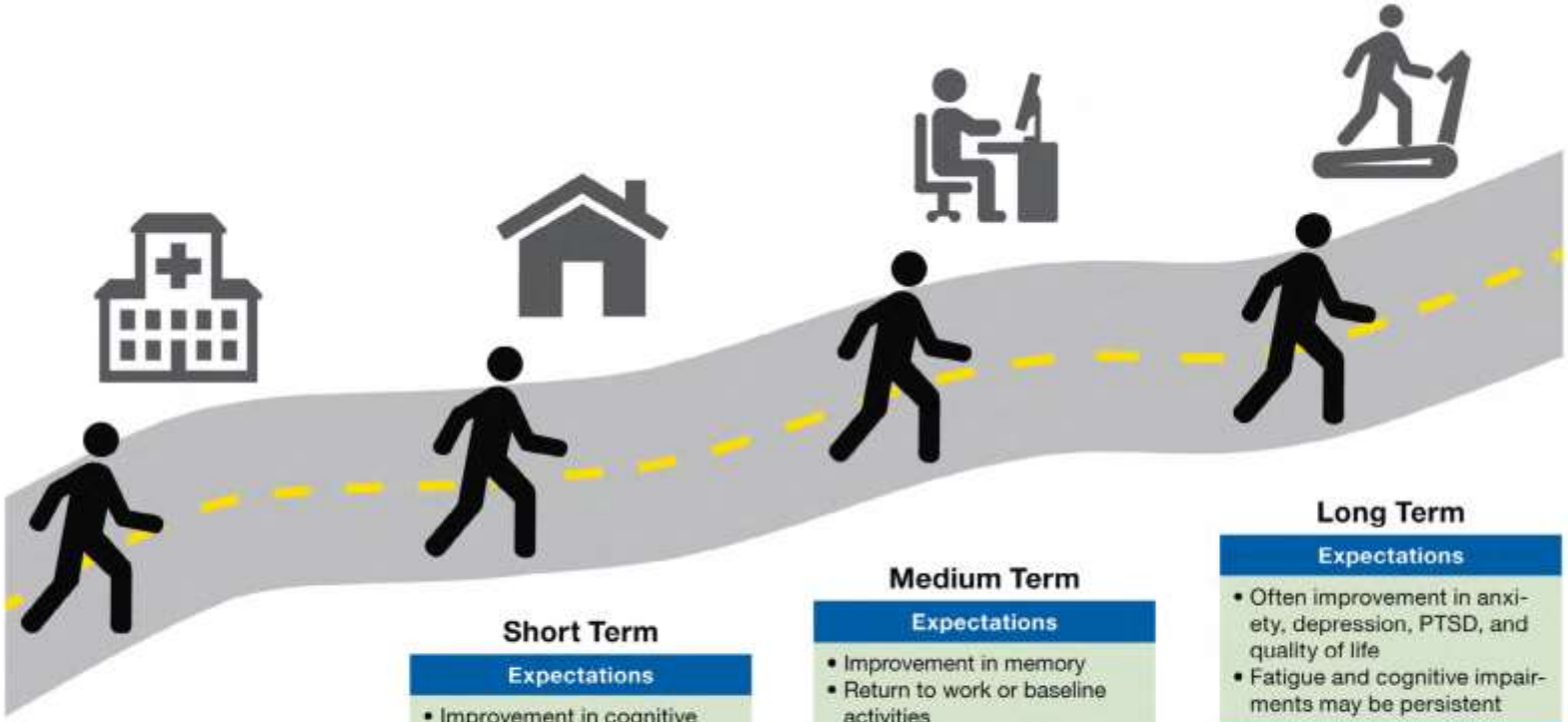
European Journal of Paediatric Neurology 28 (2020) 44–51

Practices concerning decision-making: definition, timing and consequence, all responders.

No. of respondents Frequency (%)			
Poor prognosis [1]	(N = 71)	PCPC ≥ 3 (moderate overall disability or worse)	8 [11]
		PCPC ≥ 4 (severe overall disability or worse)	35 (50)
		PCPC ≥ 5 (death, coma or vegetative state)	17 [24]
		PCPC difference ≥ 1	2 [3]
		PCPC difference ≥ 2	11 [15]
		It depends on treating physician	15 [21]
		Other	5 [7]
		Unknown	5 [7]
Timing prognosis[1]	(N = 71)	<48 h	6 [8]
		Day 3	6 [8]
		Day 4–5	11 [15]
		>5 days	4 [6]
		>14 days	7 [10]
		Based on individual patient	45 (63)
		Other	2 [3]
		Unknown	2 [3]
Consequence[1]	(N = 71)	WLST	39 (55)
		Intensive care is continued without any restrictions	4 [6]
		Intensive care support is continued with restrictions	27 [38]
		There is no standard policy	20 [28]
		Depends on the parents' wishes	26 [37]
		Other	5 [7]
Ethicist[1]	(N = 71)	No	14 [20]
		Yes, always in case of end-of-life decision making	7 [10]
		Yes, but it happens on individual basis	50 (70)



Ultra-Short Term

Expectations

- Early physical recovery, identification of underlying cause, potential recognition of cognitive challenges, highest risk for anxiety/PTSD
- Monitoring for seizures and medication side effects
- Reassessment of swallowing

Action Plan

- Work with PT/OT/SLP/rehabilitation to recover strength/function
- Discuss cognitive/behavioral changes with PT/OT/SLP and family
- Seek strategies, psychology/neuropsychology referral, and medication management/weaning

Short Term

Expectations

- Improvement in cognitive function
- Ongoing improvement in activities of daily living and cardiovascular resilience

Action Plan

- Continue strategies and behavioral activations
- Increase cardiovascular exercise

Medium Term

Expectations

- Improvement in memory
- Return to work or baseline activities

Action Plan

- Continue strategies
- Consider involvement in support group, prevention of recurrent arrest, and family member evaluation

Long Term

Expectations

- Often improvement in anxiety, depression, PTSD, and quality of life
- Fatigue and cognitive impairments may be persistent

Action Plan

- Continue strategies
- Prevent recurrent arrest
- Evaluate family members

TIPNET

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TRATTAMENTO POST RIANIMATORIO DEL BAMBINO RICOVERATO IN TERAPIA INTENSIVA PEDIATRICA DOPO ARRESTO CARDIACO

CONGRESSO NAZIONALE IRC 2023

Vicenza

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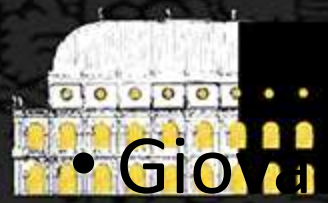

- Gio

LA RIVOLUZIONE DEI SISTEMI

- Terapia Intensiva Pediatrica
  Dipartimento di Anestesia, Rianimazione ed Emergenza-Urgenza, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milano, Italia

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