VŠEOBECNÁ FAKULTNÍ NEMOCNICE V PRAZE

1. LÉKAŘSKÁ FAKULTA Univerzita Karlova

Postresuscitační péče

Jiří Karásek
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VŠEOBECNÁ FAKULTNÍ NEMOCNICE V PRAZE

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EPIDEMIOLOGIE

- Incidence 67-170 /100 tis.
- Resuscitace zahájena či pokračováno u 50-60%
- KPR svědky 58%, AED 28%
- 80% TANR
- Propuštění 8%

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EUROPEAN RESUSCITATION COUNCIL

European Resuscitation Council Guidelines 2021: Epidemiology of cardiac arrest in Europe

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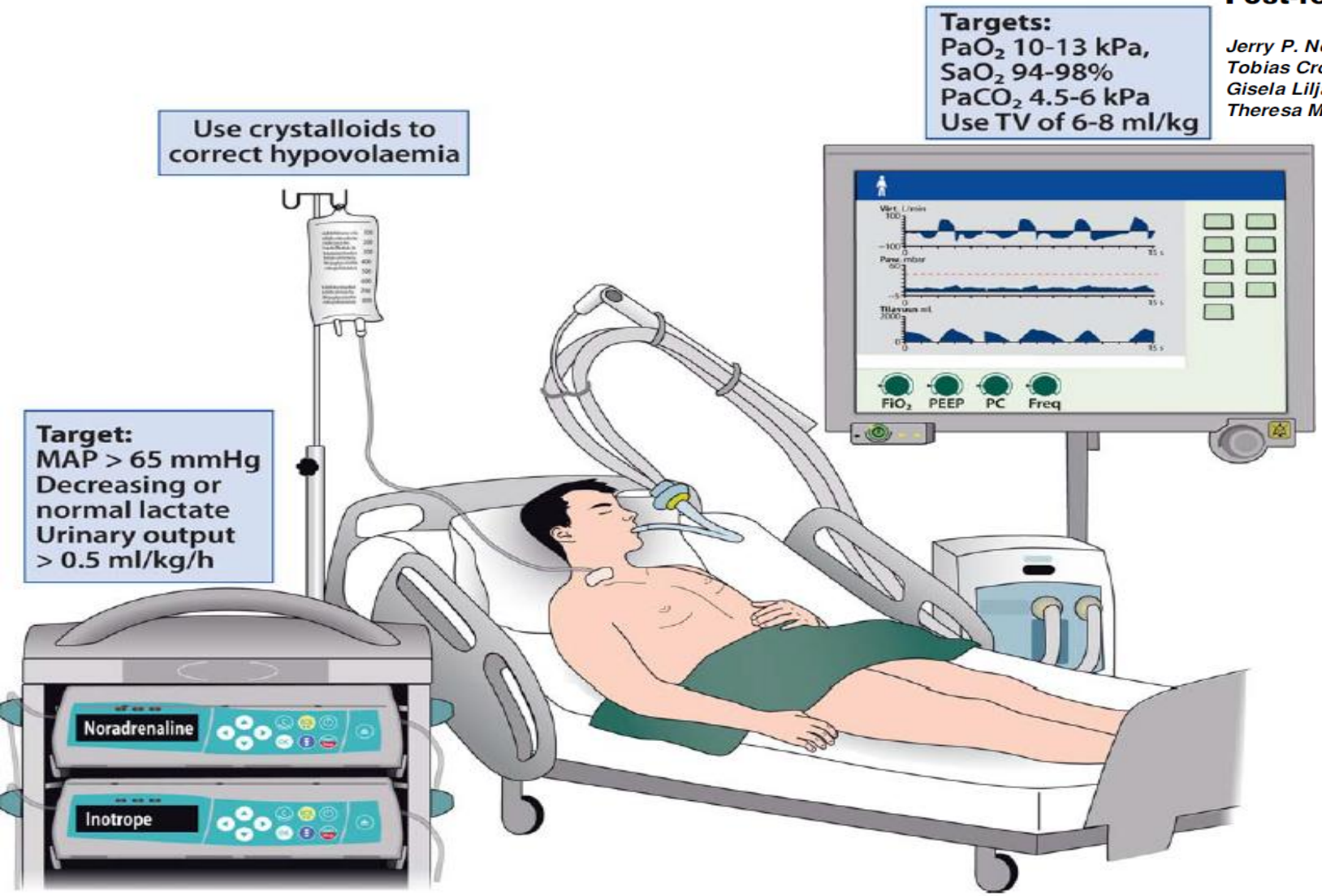
European Resuscitation Council and European Society of Intensive Care Medicine Guidelines 2021: Post-resuscitation care☆

Jerry P. Nolan[a,b,1,], Claudio Sandroni[c,d,1], Bernd W. Böttiger[e], Alain Cariou[f], Tobias Cronberg[g], Hans Friberg[h], Cornelia Genbrugge[i,j], Kirstie Haywood[k], Gisela Lilja[l], Véronique R.M. Moulaert[m], Nikolaos Nikolaou[n], Theresa Mariero Olasveengen[o], Markus B. Skrifvars[p], Fabio Taccone[q], Jasmeet Soar[r]*



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POST-RESUSCITATION CARE

EUROPEAN RESUSCITATION COUNCIL GUIDELINES 2021

IMMEDIATE TREATMENT

Airway and breathing
- Maintain SpO_2 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

Cause for cardiac arrest identified? — NO / YES

Consider CT brain and/or CTPA

Treat non-cardiac cause of cardiac arrest

Admit to ICU

OPTIMISING RECOVERY

ICU management
- Temperature control: constant temperature 32°C – 36°C for ≥ 24h; prevent fever for at least 72h
- Maintain normoxia and normocapnia; protective ventilation
- Avoid hypotension
- Echocardiography
- Maintain normoglycaemia
- Diagnose/treat seizures (EEG, sedation, anti-epileptic drugs)
- Delay prognostication for at least 72h

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

Functional assessments before hospital discharge

Structured follow up after hospital discharge

Rehabilitation

oxygenace/ventilace

oběhová podpora

kontrola tělesné teploty

diagnostický algoritmus

neuroprognostifikace/konvulze

VŠEOBECNÁ FAKULTNÍ NEMOCNICE V PRAZE

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Oxygenace a ventilace

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Control of oxygenation

- After ROSC, use 100% (or maximum available) inspired oxygen until the arterial oxygen saturation or the partial pressure of arterial oxygen can be measured reliably.
- After ROSC, once SpO_2 can be measured reliably or arterial blood gas values are obtained, titrate the inspired oxygen to achieve an arterial oxygen saturation of 94—98% or arterial partial pressure of oxygen (PaO_2) of 10—13 kPa or 75—100 mmHg (Fig. 3).
- Avoid hypoxaemia ($PaO_2 < 8$ kPa or 60 mmHg) following ROSC.
- Avoid hyperoxaemia following ROSC.

Control of ventilation

- Obtain an arterial blood gas and use end tidal CO_2 in mechanically ventilated patients.
- In patients requiring mechanical ventilation after ROSC, adjust ventilation to target a normal arterial partial pressure of carbon dioxide ($PaCO_2$) i.e. 4.5—6.0 kPa or 35—45 mmHg.
- In patients treated with targeted temperature management (TTM) monitor $PaCO_2$ frequently as hypocapnia may occur.
- During TTM and lower temperatures use consistently either a temperature or non-temperature corrected approach for measuring blood gas values.
- Use a lung protective ventilation strategy aiming for a tidal volume of 6—8 mL kg^{-1} ideal body weight.

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BOX

- CRT 2x2 factorial design
- Comatose OHCA patients 1:1, TTM 36, MV 24 h at least
- Restrictive oxygen target (PaO2 9-10kPa)-FiO2 0,3 vs. liberal oxygen target (PaO2 13-14kPa)-FiO2 0,6.
- 789 patients (394 vs. 395)
- Primary outcome: composite of death from any cause or hospital discharge CPC 3,4 to D90
- Secondary outcomes: NSE at H48, death from any cause, cognitive ability scores and CPC at day 90

Table 2. Primary and Secondary Outcomes and Adverse Events.*

Variable	Restrictive Oxygen Target (N=394)	Liberal Oxygen Target (N=395)	Treatment Effect (95% CI)†	P Value
Primary outcome				
Death from any cause or CPC 3 or 4 at discharge — no. (%)‡	126 (32.0)	134 (33.9)	0.95 (0.75–1.21)	0.69
Secondary outcomes				
Death from any cause at 90 days — no. (%)	113 (28.7)	123 (31.1)	0.93 (0.72–1.20)	
Acute kidney injury with renal-replacement therapy — no. (%)	34 (8.6)	47 (11.9)	0.85 (0.69–1.03)	
Median CPC at 90 days (IQR)‡	1 (1–5)	1 (1–5)		
Median score on modified Rankin scale at 90 days (IQR)§	2 (0–6)	1 (0–6)		
Median score on Montreal Cognitive Assessment at 90 days (IQR)¶	27 (24–29)	27 (24–28)		
Median neuron-specific enolase at 48 hr (IQR) — μg/liter‖	17 (11–36)	18 (11–34)		
Adverse events — no. (%)				
Infection**	103 (26.1)	109 (27.6)	0.96 (0.82–1.13)	0.65
Arrhythmia††	57 (14.5)	52 (13.2)	1.06 (0.86–1.30)	0.60
Bleeding				
Any	82 (20.8)	92 (23.3)	0.93 (0.79–1.10)	0.40
Uncontrolled bleeding‡‡	17 (4.3)	21 (5.3)	0.90 (0.67–1.21)	0.62
Acute kidney injury with renal-replacement therapy	34 (8.6)	47 (11.9)	0.85 (0.69–1.03)	0.13
Electrolyte disorder§§	32 (8.1)	25 (6.3)	1.15 (0.85–1.56)	0.33
Metabolic disorder¶¶	34 (8.6)	28 (7.1)	1.12 (0.84–1.48)	0.42
Seizure‖‖	81 (20.6)	83 (21.0)	0.99 (0.83–1.17)	0.14

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Podpora oběhu

European Resuscitation Council and European Society of Intensive Care Medicine Guidelines 2021: Post-resuscitation care☆

Jerry P. Nolan[a,b,1,], Claudio Sandroni[c,d,1], Bernd W. Böttiger[e], Alain Cariou[f], Tobias Cronberg[g], Hans Friberg[h], Cornelia Genbrugge[i,j], Kirstie Haywood[k], Gisela Lilja[l], Véronique R.M. Moulaert[m], Nikolaos Nikolaou[n], Theresa Mariero Olasveengen[o], Markus B. Skrifvars[p], Fabio Taccone[q], Jasmeet Soar[r]*

Haemodynamic monitoring and management

- All patients should be monitored with an arterial line for continuous blood pressure measurements, and it is reasonable to monitor cardiac output in haemodynamically unstable patients.
- Perform early (as soon as possible) echocardiography in all patients to detect any underlying cardiac pathology and quantify the degree of myocardial dysfunction.
- Avoid hypotension (<65 mmHg). Target mean arterial pressure (MAP) to achieve adequate urine output (>0.5 mL kg^{-1} h^{-1}) and normal or decreasing lactate (Fig. 3).
- During TTM at 33 °C, bradycardia may be left untreated if blood pressure, lactate, $ScvO_2$ or SvO_2 is adequate. If not, consider increasing the target temperature, but to no higher than 36 °C.
- Maintain perfusion with fluids, noradrenaline and/or dobutamine, depending on individual patient need for intravascular volume, vasoconstriction or inotropy.
- Do not give steroids routinely after cardiac arrest.
- Avoid hypokalaemia, which is associated with ventricular arrhythmias.

VŠEOBECNÁ FAKULTNÍ NEMOCNICE V PRAZE | 1. LÉKAŘSKÁ FAKULTA Univerzita Karlova

BOX

- CRT 2x2 factorial design
- Comatose OHCA patients 1:1, TTM 36
- key exclusions: unwitnessed asystole or IC bleeding or stroke
- MAP: 63 mm Hg vs. MAP 77 mm Hg
- 789 patients (393 vs. 396)
- Blinded calibration of MAP devices (70 mm Hg for all, but real +/- 10%)
- MAP maintained with fluidws to CVP 10 mm Hg, norepinephrine and the addition dopamine if needed
- Primary outcome: composite of death from any cause or hospital discharge CPC 3,4 to D90
- Secondary outcomes: NSE at H48, death from any cause, cognitive ability scores and CPC at day 90

Table 2. Outcomes and Adverse Events.*

Outcome or Event	High Blood-Pressure Target (N=393)	Low Blood-Pressure Target (N=396)	Hazard Ratio (95% CI)	P Value
Primary outcome				
Death from any cause or CPC of 3 or 4 at discharge within 90 days — no. (%)†	133 (34)	127 (32)	1.08 (0.84–1.37)	0.56
Secondary outcomes				
Death from any cause within 90 days — no. (%)	122 (31)	114 (29)	1.13 (0.88–1.46)	
Acute kidney injury with renal-replacement therapy — no. (%)	41 (10)	40 (10)	1.03 (0.66–1.59)	
Median CPC at 3 months (IQR)†	1 (1–5)	1 (1–5)		
Median modified Rankin scale score at 3 months (IQR)‡	1 (0–6)	1 (0–6)		
Median Montreal Cognitive Assessment score, per protocol (IQR)§	20 (15–27)	21 (15–27)		
Median Montreal Cognitive Assessment score at 3 months, post hoc (IQR)§	27 (24–29)	26 (24–29)		
Median neuron-specific enolase level at 48 hours (IQR) — μg/liter¶	18 (11–37)	18 (11–34)		
			Relative Risk (95% CI)	
Serious adverse events — no. (%)				
Infection‖	102 (26)	110 (28)	0.96 (0.82–1.11)	0.56
Arrhythmia**	59 (15)	50 (13)	1.10 (0.79–1.38)	0.33
Any bleeding††	82 (21)	92 (23)	0.93 (0.79–1.10)	0.43
Uncontrolled bleeding††	22 (6)	16 (4)	0.85 (0.64–1.13)	0.31
Electrolyte disorder‡‡	23 (6)	34 (9)	0.82 (0.66–1.04)	0.13
Metabolic disorder§§	31 (8)	31 (8)	1.00 (0.77–1.30)	0.98
Seizure¶¶	76 (19)	88 (22)	0.92 (0.78–1.08)	0.32

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Kontrola tělesné teploty

Temperature control

- Maintain a constant, target temperature between 32 °C and 36 °C for those patients in whom temperature control is used (strong recommendation, moderate-quality evidence).
- Whether certain subpopulations of cardiac arrest patients may benefit from lower (32–34 °C) or higher (36 °C) temperatures remains unknown, and further research may help elucidate this.
- TTM is recommended for adults after OHCA with an initial shockable rhythm who remain unresponsive after ROSC (strong recommendation, low-quality evidence).
- TTM is suggested for adults after OHCA with an initial non-shockable rhythm who remain unresponsive after ROSC (weak recommendation, very low-quality evidence).
- TTM is suggested for adults after IHCA with any initial rhythm who remain unresponsive after ROSC (weak recommendation, very low-quality evidence).
- If targeted temperature management is used, it is suggested that the duration is at least 24 h (weak recommendation, very low-quality evidence).

- We recommend TTM for adults after either OHCA or IHCA (with any initial rhythm) who remain unresponsive after ROSC.
- Maintain a target temperature at a constant value between 32 °C and 36 °C for at least 24 h.
- Avoid fever (>37.7 °C) for at least 72 h after ROSC in patients who remain in coma.

A recent randomised controlled trial of both IHCA and OHCA patients with initial non-shockable rhythms showed a higher percentage of patients survived with a favourable neurological outcome when treated with TTM at 33 °C versus 37 °C.[13] This has enabled the recommendation to be extended to all rhythms and locations.

The definition of fever (>37.7 °C) is consistent with that used in the TTM2 trial.[14]

Kontrola tělesné teploty

Temperature control

- We recommend targeted temperature management (TTM) for adults after either OHCA or in-hospital cardiac arrest (IHCA) (with any initial rhythm) who remain unresponsive after ROSC.
- Maintain a target temperature at a constant value between 32 °C and 36 °C for at least 24 h.
- Avoid fever (>37.7 °C) for at least 72 h after ROSC in patients who remain in coma.
- Do not use pre-hospital intravenous cold fluids to initiate hypothermia.

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Hyperion

- 33°C vs. 37°C u nedefibr. rytmu
- prim. outcome: 90. den CPC 1,2
- sekund. outcome: 90. denní mortalita
- IHCA i OHCA

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Targeted Temperature Management for Cardiac Arrest with Nonshockable Rhythm

J.-B. Lascarrou, H. Merdji, A. Le Gouge, G. Colin, G. Grillet, P. Girardie, E. Coupez, P.-F. Dequin, A. Cariou, T. Boulain, N. Brule, J.-P. Frat, P. Asfar, N. Pichon, M. Landais, G. Plantefeve, J.-P. Quenot, J.-C. Chakarian, M. Sirodot, S. Legriel, J. Letheulle, D. Thevenin, A. Desachy, A. Delahaye, V. Botoc, S. Vimeux, F. Martino, B. Giraudeau, and J. Reignier, for the CRICS-TRIGGERSEP Group*

Table 2. Neurologic Outcomes and Hospitalization Characteristics.*

Outcome	Hypothermia (N=284)	Normothermia (N=297)	Difference or Hazard Ratio (95% CI)
CPC score of 1 or 2 on day 90 — no. (%)	29 (10.2)	17 (5.7)	4.5 (0.1 to 8.9)†
CPC score distribution on day 90 — no. (%)			
CPC score of 1	16 (5.6)	11 (3.7)	
CPC score of 2	13 (4.6)	6 (2.0)	
CPC score of 3	22 (7.7)	31 (10.4)	
CPC score of 4	1 (0.4)	0	
CPC score of 5	231 (81.3)	247 (83.2)	
Loss to follow-up	1 (0.4)	2 (0.7)	
Death by day 90 — no. (%)	231 (81.3)	247 (83.2)	−1.9 (−8.0 to 4.4)†
Death in the ICU — no. (%)	222 (78.2)	236 (79.5)	0.93 (0.78 to 1.10)‡
Duration of mechanical ventilation — days			
Median	4.5	4.0	
Interquartile range	2.0 to 7.0	2.0 to 7.0	
Length of stay in ICU — days			
Median	4.0	4.0	
Interquartile range	2.0 to 7.0	2.0 to 6.0	
Survival to ICU discharge — no. (%)	62 (21.8)	61 (20.5)	1.07 (0.75 to 1.52)‡
Duration of mechanical ventilation — days			
Median	11.0	10.0	
Interquartile range	6.0 to 24.0	4.0 to 27.0	
Length of stay in ICU — days			
Median	6.0	6.0	
Interquartile range	4.0 to 18.0	2.0 to 21.0	
Survival to hospital discharge — no. (%)	56 (19.7)	50 (16.8)	1.19 (0.81 to 1.74)‡

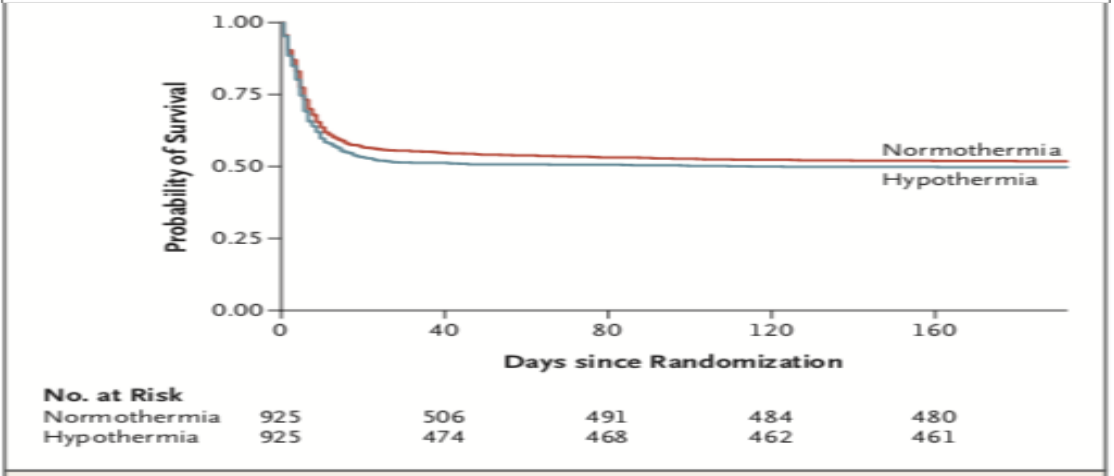
ORIGINAL ARTICLE

Hypothermia versus Normothermia after Out-of-Hospital Cardiac Arrest

J. Dankiewicz, T. Cronberg, G. Lilja, J.C. Jakobsen, H. Levin, S. Ullén, C. Rylander, M.P. Wise, M. Oddo, A. Cariou, J. Bělohlávek, J. Hovdenes, M. Saxena, H. Kirkegaard, P.J. Young, P. Pelosi, C. Storm, F.S. Taccone, M. Joannidis, C. Callaway, G.M. Eastwood, M.P.G. Morgan, P. Nordberg, D. Erlinge, A.D. Nichol, M.S. Chew, J. Hollenberg, M. Thomas, J. Bewley, K. Sweet, A.M. Grejs, S. Christensen, M. Haenggi, A. Levis, A. Lundin, J. Düring, S. Schmidbauer, T.R. Keeble, G.V. Karamasis, C. Schrag, E. Faessler, O. Smid, M. Otáhal, M. Maggiorini, P.D. Wendel Garcia, P. Jaubert, J.M. Cole, M. Solar, O. Borgquist, C. Leithner, S. Abed-Maillard, L. Navarra, M. Annborn, J. Undén, I. Brunetti, A. Awad, P. McGuigan, R. Bjørkholt Olsen, T. Cassina, P. Vignon, H. Langeland, T. Lange, H. Friberg, and N. Nielsen, for the TTM2 Trial Investigators*

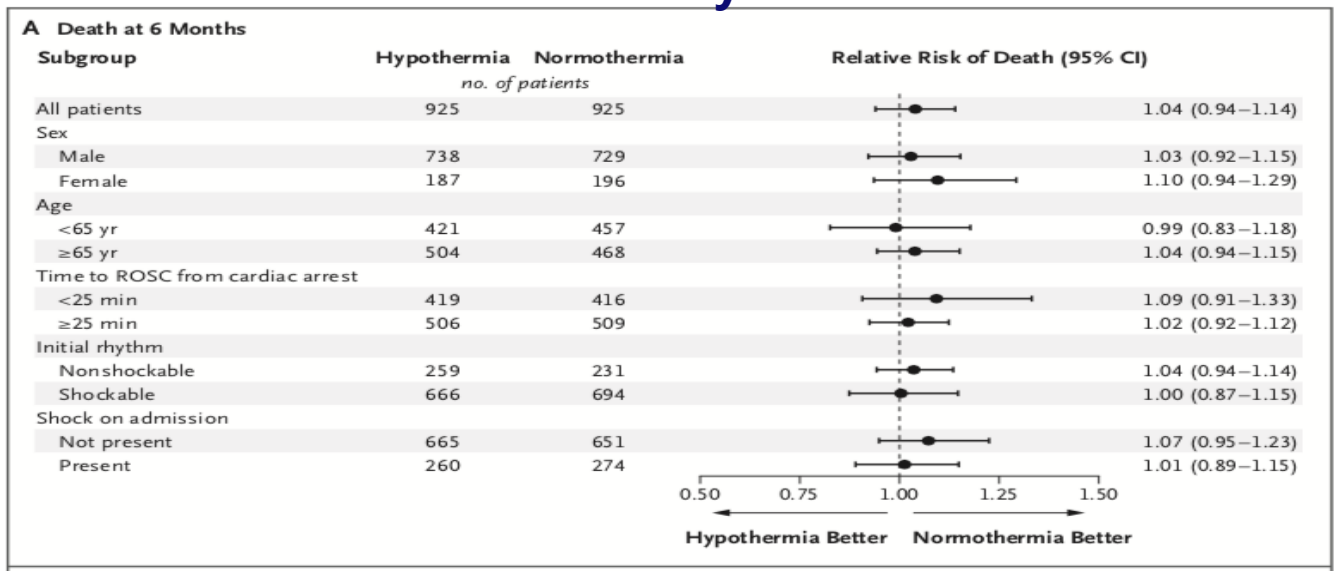
Table 2. Outcomes and Adverse Events.

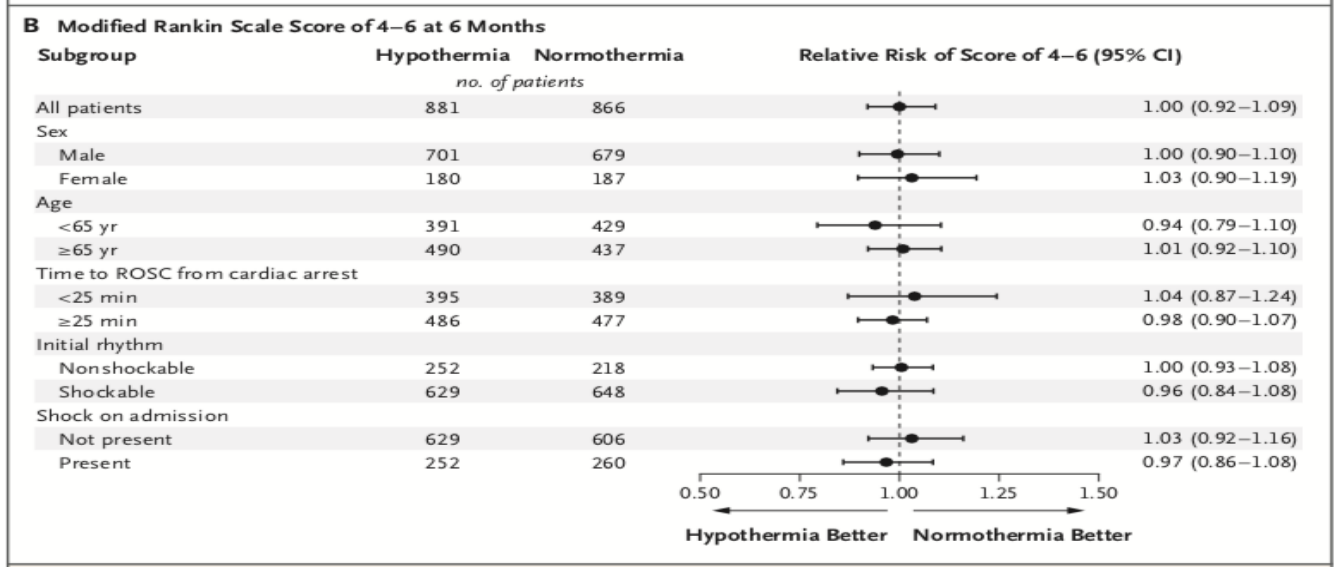
Outcome or Event	Hypothermia (N=930)	Normothermia (N=931)	Relative Risk (95% CI)*	P Value
Primary outcome: death from any cause at 6 mo — no./total no. (%)	465/925 (50)	446/925 (48)	1.04 (0.94–1.14)	0.37
Main secondary outcome — no./total no. (%)				
Score of 4–6 on modified Rankin scale at 6-mo follow-up†	488/881 (55)	479/866 (55)	1.00 (0.92–1.09)	
Poor functional outcome at 6 mo‡	495/918 (54)	493/911 (54)	1.00 (0.91–1.08)	
Score on modified Rankin scale at 6-mo follow-up — no./total no. (%)†				
0	140/881 (16)	148/866 (17)		
1	87/881 (10)	80/866 (9)		
2	132/881 (15)	127/866 (15)		
3	34/881 (4)	32/866 (4)		
4	16/881 (2)	20/866 (2)		
5	7/881 (1)	13/866 (2)		
6	465/881 (53)	446/866 (52)		
Serious adverse events — no./total no. (%)				
Arrhythmia resulting in hemodynamic compromise	222/927 (24)	152/921 (16)	1.45 (1.21–1.75)	<0.001
Bleeding	44/927 (5)	46/922 (5)	0.95 (0.63–1.42)	0.81
Skin complication related to device used for targeted temperature management	10/927 (1)	5/922 (<1)	1.99 (0.71–6.37)	0.21
Pneumonia	330/927 (36)	322/921 (35)	1.02 (0.90–1.15)	0.75
Sepsis	99/926 (11)	83/922 (9)	1.19 (0.90–1.57)	0.23



TTM 2

33^{0}C vs. normotermie do 37.8 ^{0}C
primární outocome: 6-měs. mortalita
sekundární outcome: 6-měs. mRS ≥4
OHCA bez ohledu na inic. rytmus





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NEJM Evidence

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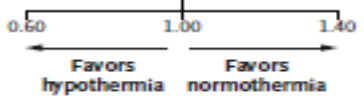
ORIGINAL ARTICLE

Hypothermic versus Normothermic Temperature Control after Cardiac Arrest

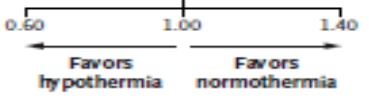
Meta-analysis of all-cause mortality (including subgroups)

Outcome →	Hypothermia Died	Hypothermia Survived	Normothermia Died	Normothermia Survived	Risk Ratio with 95% CI
TTM1	226	247	220	246	1.01 0.88 to 1.16
TTM2	465	460	446	479	1.04 0.95 to 1.14
					1.03 0.96 to 1.11
					P = 0.41
Sex					
Male	528	603	498	599	1.03 0.94 to 1.13
Female	163	104	168	126	1.07 0.93 to 1.23
Age					
<65 years	230	414	234	454	1.05 0.91 to 1.22
≥65 years	461	293	431	272	1.00 0.92 to 1.08
Time to ROSC from arrest					
<25 min	221	414	209	419	1.05 0.90 to 1.22
≥25 min	470	293	456	306	1.03 0.95 to 1.12
Initial rhythm					
Nonshockable	288	69	252	67	1.02 0.95 to 1.10
Shockable	403	638	413	658	1.00 0.90 to 1.12
Shock on admission					
Not present	473	594	447	602	1.04 0.94 to 1.15
Present	218	112	218	123	1.03 0.92 to 1.15
Time to ALS					
≥10 min	405	325	373	322	1.03 0.94 to 1.14
<10 min	285	375	287	400	1.03 0.91 to 1.17
Bystander CPR					
No bystander CPR	171	128	209	119	0.88 0.77 to 1.02
Bystander CPR	520	579	455	606	1.10 1.01 to 1.21
Witnessed arrest					
Witnessed arrest	609	656	595	670	1.02 0.94 to 1.11
Unwitnessed arrest	82	51	70	55	1.10 0.90 to 1.35



Meta-analyses of functional outcome (including subgroups)

Functional outcome →	Hypothermia Poor	Hypothermia Good	Normothermia Poor	Normothermia Good	Risk Ratio with 95% CI
TTM1	245	224	239	225	1.01 0.90 to 1.15
TTM2	488	393	479	387	1.00 0.92 to 1.09
					1.01 0.94 to 1.08
					P = 0.88
Sex					
Male	563	527	536	510	1.01 0.93 to 1.09
Female	170	90	182	102	1.02 0.90 to 1.16
Age					
<65 years	250	361	261	387	1.02 0.89 to 1.16
≥65 years	483	256	457	225	0.98 0.91 to 1.05
Time to ROSC from arrest					
<25 min	236	373	237	362	0.98 0.85 to 1.13
≥25 min	497	244	480	250	1.02 0.95 to 1.10
Initial rhythm					
Nonshockable	298	51	259	47	1.01 0.95 to 1.08
Shockable	435	566	458	565	0.97 0.88 to 1.07
Shock on admission					
Not present	508	521	487	515	1.02 0.93 to 1.11
Present	225	96	230	97	1.00 0.90 to 1.10
MIRACLE2 risk group					
High risk	281	43	259	37	0.99 0.93 to 1.05
Intermediate risk	282	215	268	211	1.01 0.91 to 1.13
Low risk	60	283	87	315	0.81 0.60 to 1.09
Time to ALS					
≥10 min	427	286	395	271	1.01 0.93 to 1.10
<10 min	305	326	317	338	1.00 0.89 to 1.12
Bystander CPR					
No bystander CPR	183	108	224	91	0.88 0.79 to 0.99
Bystander CPR	550	509	492	520	1.07 0.98 to 1.16
Witnessed arrest					
Witnessed arrest	647	572	644	562	0.99 0.92 to 1.07
Unwitnessed arrest	86	45	73	50	1.11 0.91 to 1.34



Diagnosis of cause of cardiac arrest

- Early identification of a respiratory or neurological cause can be achieved by performing a brain and chest CT-scan at hospital admission, before or after coronary angiography (see coronary reperfusion).
- In the absence of signs or symptoms suggesting a neurological or respiratory cause (e.g. headache, seizures or neurological deficits, shortness of breath or documented hypoxaemia in patients with known respiratory disease) or if there is clinical or ECG evidence of myocardial ischaemia, undertake coronary angiography first. This is followed by CT scan if coronary angiography fails to identify causative lesions.

Coronary reperfusion

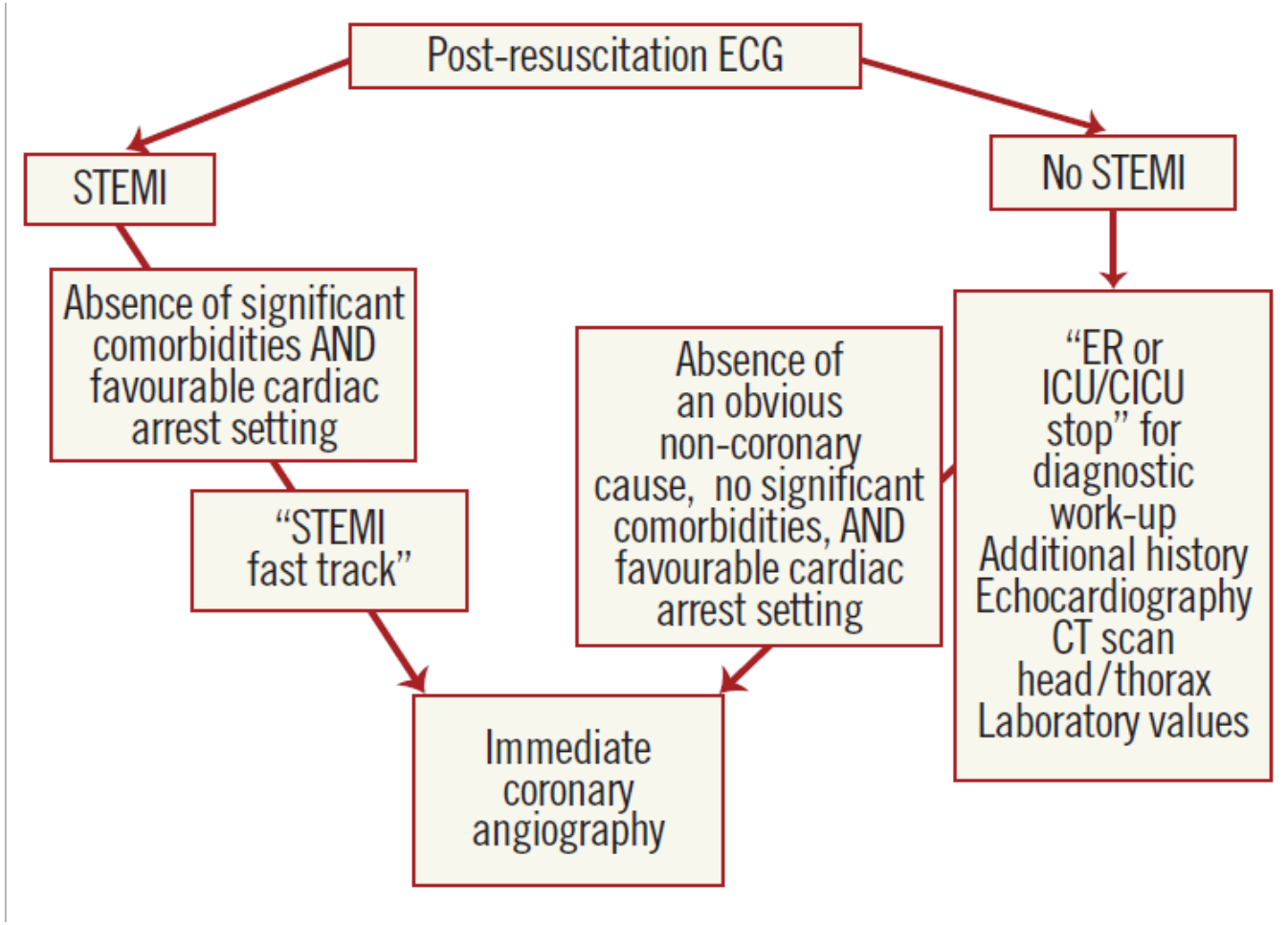
- Emergent cardiac catheterisation laboratory evaluation (and immediate PCI if required) should be performed in adult patients with ROSC after cardiac arrest of suspected cardiac origin with ST-elevation on the ECG.
- In patients with ROSC after out-of-hospital cardiac arrest (OHCA) without ST-elevation on the ECG, emergent cardiac catheterisation laboratory evaluation should be considered if there is an estimated high probability of acute coronary occlusion (e.g. patients with haemodynamic and/or electrical instability).

2015 Guidelines	2021 Guidelines	Rationale for change
Coronary angiography		
It is reasonable to discuss and consider emergent cardiac catheterisation laboratory evaluation after ROSC in patients with the highest risk of a coronary cause for their cardiac arrest	In patients with ROSC after OHCA without ST-elevation on the ECG, emergent cardiac catheterisation laboratory evaluation should be considered if there is an estimated high probability of acute coronary occlusion (e.g. patients with haemodynamic and/or electrical instability).	A randomised controlled trial showed no difference in 90-day survival following out of hospital VF cardiac arrest among patients without ST-elevation on the ECG allocated to immediate coronary angiography versus delayed angiography.[10] Recent ESC guidelines state that 'Delayed as opposed to immediate angiography should be considered in haemodynamically stable patients without ST-segment elevation successfully resuscitated after an out-of-hospital cardiac arrest'.[11]

Diagnostika

Invasive coronary treatment strategies for out-of-hospital cardiac arrest: a consensus statement from the European Association for Percutaneous Cardiovascular Interventions (EAPCI)/Stent for Life (SFL) groups

Marko Noc[1], MD; Jean Fajadet[2], MD; Jens F. Lassen[3], MD; Petr Kala[4], MD; Philip MacCarthy[5], MD; Goran K. Olivecrona[6], MD; Stephan Windecker[7], MD; Christian Spaulding[8*], MD



VŠEOBECNÁ FAKULTNÍ NEMOCNICE V PRAZE

1. LÉKAŘSKÁ FAKULTA Univerzita Karlova

(Summary of the 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. Prepared by the Czech Society of Cardiology)

Tabulka 13 – Riziková kritéria vyžadující invazivní strategii u non-STE AKS

Kritéria velmi vysokého rizika
• Hemodynamická nestabilita nebo kardiogenní šok
• Recidivující nebo pokračující bolest na hrudi refrakterní k medikamentózní léčbě
• Život ohrožující arytmie nebo srdeční zástava
• Mechanické komplikace infarktu myokardu
• Akutní srdeční selhání
• Recidivující dynamické změny ST nebo vlny T zejména s intermitentními elevacemi úseku ST

5.6.3 Načasování invazivní strategie

■ ***Okamžitá invazivní strategie (< 2 h)***

Pacienti s non-STE AKS a velmi vysokým rizikem (tabulka 13) mají bez léčby špatnou prognózu. Doporučuje se okamžitá (tj. < 2 h od přijetí k hospitalizaci, analogická léčbě STEMI) invazivní strategie bez ohledu na EKG nebo výsledky biomarkerů. Centra bez STEMI programu by měla tyto pacienty okamžitě přeložit (obr. 6). Léčba pacientů se srdeční zástavou mimo nemocnici a bez STE na EKG musí být individualizována a vyžaduje multidisciplinární konzultaci. Ti, kteří jsou při vědomí, by měli okamžitě podstoupit SKG.

Doporučené postupy ESC pro léčbu akutního infarktu myokardu u pacientů s elevacemi úseku ST, 2017: souhrn dokumentu vypracovaný Českou kardiologickou společností

(2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: Summary of the document prepared by the Czech Society of Cardiology)

ČESKÁ KARDIOLOGICKÁ SPOLEČNOST THE CZECH SOCIETY OF CARDIOLOGY

Petr Kala[a], Martin Mates[b], Michael Želízko[c], Richard Rokyta[d], Petr Ošťádal[b]

Srdeční zástava

Doporučení	Třída[a]	Úroveň[b]
U pacientů po resuscitaci pro srdeční zástavu s EKG záznamem odpovídajícím STEMI je doporučena strategie primární PCI.	I	B
U pacientů, kteří v časném období po resuscitaci pro srdeční zástavu dále nereagují, je indikována cílená regulace tělesné teploty.[c]	I	B
Je indikováno, aby zdravotní systémy uplatňovaly strategie pro usnadnění převozu (jednou specializovanou záchrannou službou) všech pacientů s podezřením na IM přímo do nemocnic s nonstop (24/7) možností reperfuzní léčby formou PCI.	I	C
Je doporučeno, aby všichni lékaři a zdravotničtí pracovníci pečující o osoby s podezřením na IM měli přístup k defibrilátorům a byli vyškoleni v poskytování základní podpory srdeční a životních funkcí.	I	C
U pacientů po resuscitaci pro srdeční zástavu bez diagnostických elevací úseku ST, ale s vysokým podezřením na probíhající ischemii myokardu by měla být zvážena urgentní koronarografie (a PCI, pokud je indikována).	IIa	C
Přednemocniční chlazení rychlou i.v. aplikací velkých objemů chladné tekutiny okamžitě po obnovení spontánního oběhu není doporučeno	III	B

3.3 Srdeční zástava (tabulka 7)

K mnoha úmrtím dochází během prvních několika hodin od začátku STEMI z důvodu fibrilace komor. U resuscitovaných pacientů s elevacemi úseku ST na EKG je indikována okamžitá koronarografie. Detaily viz doporučené postupy European Resuscitation Council (ERC).

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], on behalf of the Initial management of acute coronary syndromes section Collaborator[1]

- We recommend emergency cardiac catheterisation lab evaluation (and immediate PCI if required), in a manner similar to patients with STEMI without cardiac arrest, in selected adult patients with ROSC after out-of-hospital cardiac arrest (OHCA) of suspected cardiac origin with ST-elevation on ECG.
- In patients who are comatose and with ROSC after OHCA of suspected cardiac origin without ST-elevation on ECG It is reasonable to consider an emergency cardiac catheterisation lab evaluation in patients with the highest risk of coronary cause cardiac arrest.

The invasive management (i.e. early coronary angiography (CAG) followed by immediate PCI if deemed necessary) of this patient group, particularly patients after prolonged resuscitation and having nonspecific ECG changes, has been controversial due to the lack of specific evidence and significant implications on resource utilization (including transfer of patients to PCI centres).

VŠEOBECNÁ FAKULTNÍ NEMOCNICE V PRAZE

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COACT

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 APRIL 11, 2019 VOL. 380 NO. 15

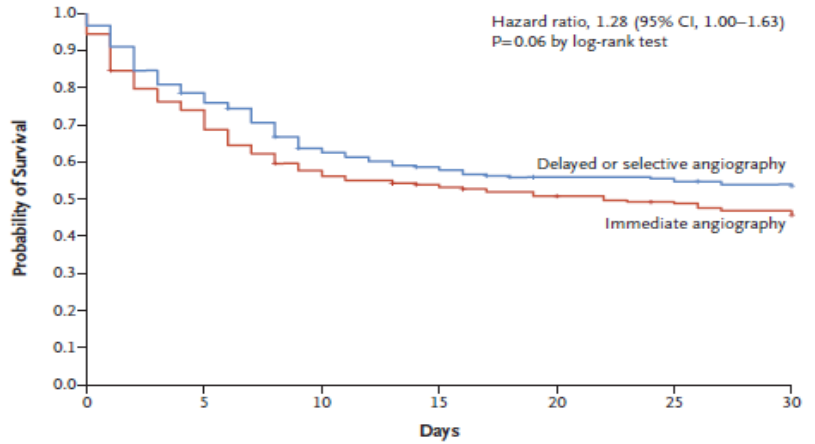
Table 3. Clinical Outcomes.*

Outcome	Immediate Angiography Group (N=273)	Delayed Angiography Group (N=265)	Effect Size (95% CI)†
Primary end point			
Survival at 90 days — no. of patients (%)‡	176 (64.5)	178 (67.2)	OR, 0.89 (0.62 to 1.27)
Secondary end points			
Survival with good cerebral performance or mild or moderate disability — no. of patients/total no. (%)	171/272 (62.9)	170/264 (64.4)	OR, 0.94 (0.66 to 1.31)
CPC score at 90 days — no./total no. (%)§			
1	157/272 (57.7)	159/264 (60.2)	Reference
2	14/272 (5.1)	11/264 (4.2)	OR, 1.29 (0.56 to 2.92)
3	4/272 (1.5)	5/264 (1.9)	OR, 0.81 (0.21 to 3.07)
4	0/272	2/264 (0.8)	NA
5	97/272 (35.7)	87/264 (33.0)	OR, 1.13 (0.78 to 1.63)
Survival until hospital discharge — no. of patients (%)	178 (65.2)	182 (68.7)	OR, 0.85 (0.60 to 1.22)
Neurologic status at ICU discharge			
GCS score			
Median (IQR)	15 (14 to 15)	15 (14 to 15)	
Geometric mean (95% CI)	13.7 (13.2 to 14.2)	13.5 (12.9 to 13.7)	1.02 (0.96 to 1.04)
CPC score — no./total no. (%)§			
1	74/258 (28.7)	86/249 (34.5)	Reference
2	59/258 (22.9)	56/249 (22.5)	OR, 1.22 (0.76 to 1.98)
3	36/258 (14.0)	30/249 (12.0)	OR, 1.39 (0.78 to 2.48)
4	4/258 (1.6)	9/249 (3.6)	OR, 0.52 (0.15 to 1.75)
5	85/258 (32.9)	68/249 (27.3)	OR, 1.45 (0.93 to 2.27)
TIMI major bleeding, any grade — no. (%)	7 (2.6)	13 (4.9)	OR, 0.51 (0.20 to 1.30)
Recurrence of ventricular tachycardia resulting in defibrillation or electrical cardioversion — no. (%)	21 (7.7)	16 (6.0)	OR, 1.30 (0.66 to 2.54)
Creatinine kinase			
Median AUC (IQR)	30,099 (9983 to 67,096)	28,006 (11,044 to 74,043)	
Geometric mean (95% CI)	25,694 (21,764 to 30,333)	25,306 (21,140 to 30,291)	1.02 (0.80 to 1.30)
Creatinine kinase MB			
Median AUC (IQR)	930 (402 to 2456)	851 (302 to 2868)	
Geometric mean (95% CI)	975 (793 to 1198)	949 (739 to 1219)	1.03 (0.74 to 1.42)
Troponin T			
Median AUC (IQR)	11.3 (4.4 to 33.5)	10.6 (4.5 to 36.2)	
Geometric mean (95% CI)	11.2 (9.2 to 13.6)	12.8 (10.3 to 16.0)	0.87 (0.64 to 1.16)
Troponin I			
Median AUC (IQR)	154.7 (33.1 to 1762)	183.2 (21.4 to 7278)	
Geometric mean (95% CI)	226.7 (100.1 to 513.2)	315.9 (116.7 to 837.5)	0.72 (0.21 to 2.54)
AKIN classification stage — no./total no. (%)¶			
0	218/244 (89.3)	214/243 (88.1)	Reference
1	12/244 (4.9)	8/243 (3.3)	OR, 1.47 (0.59 to 3.67)
2	4/244 (1.6)	5/243 (2.1)	OR, 0.79 (0.21 to 2.96)
3	10/244 (4.1)	16/243 (6.6)	OR, 0.61 (0.27 to 1.38)

TOMAHAWK

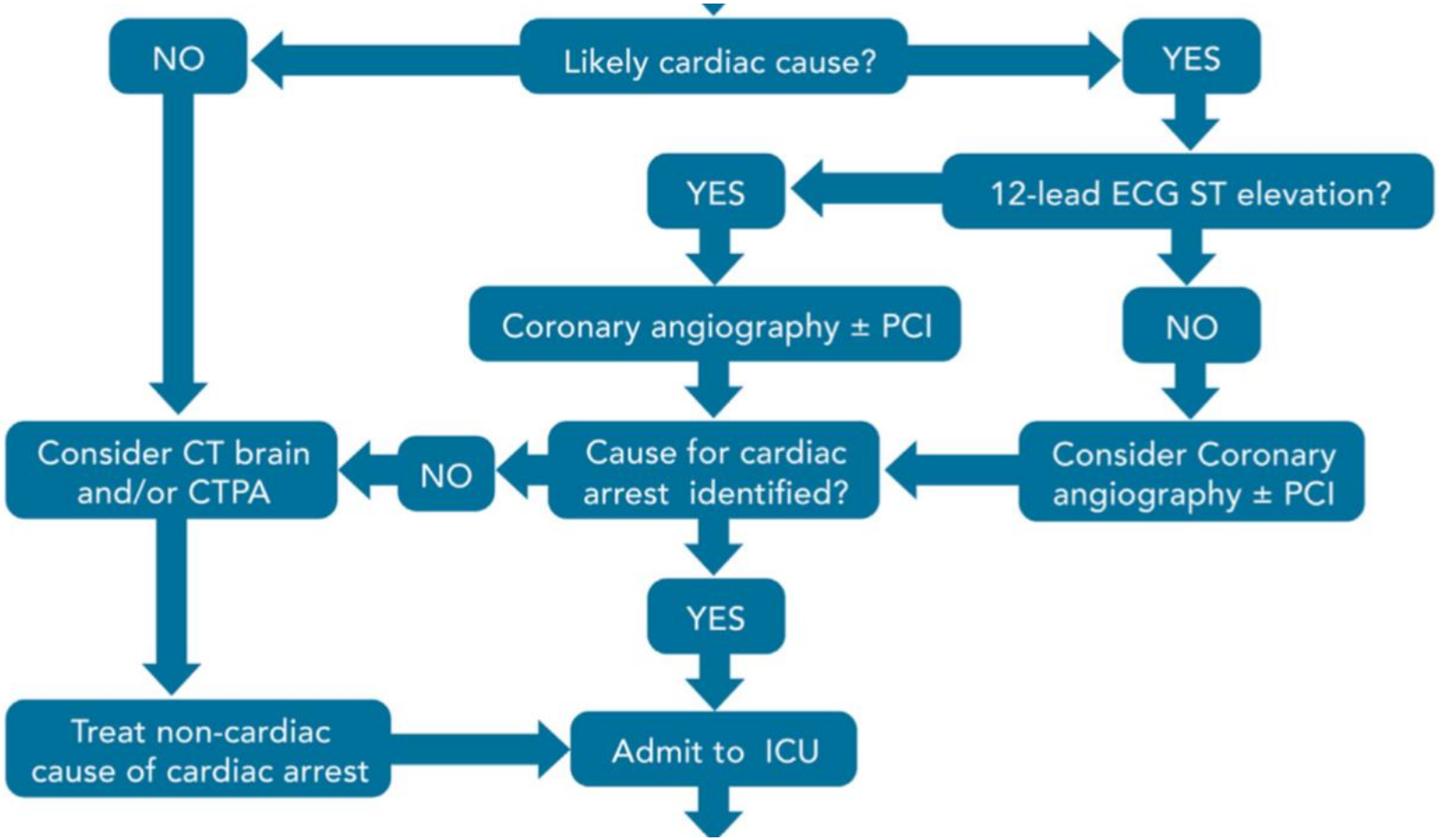
The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

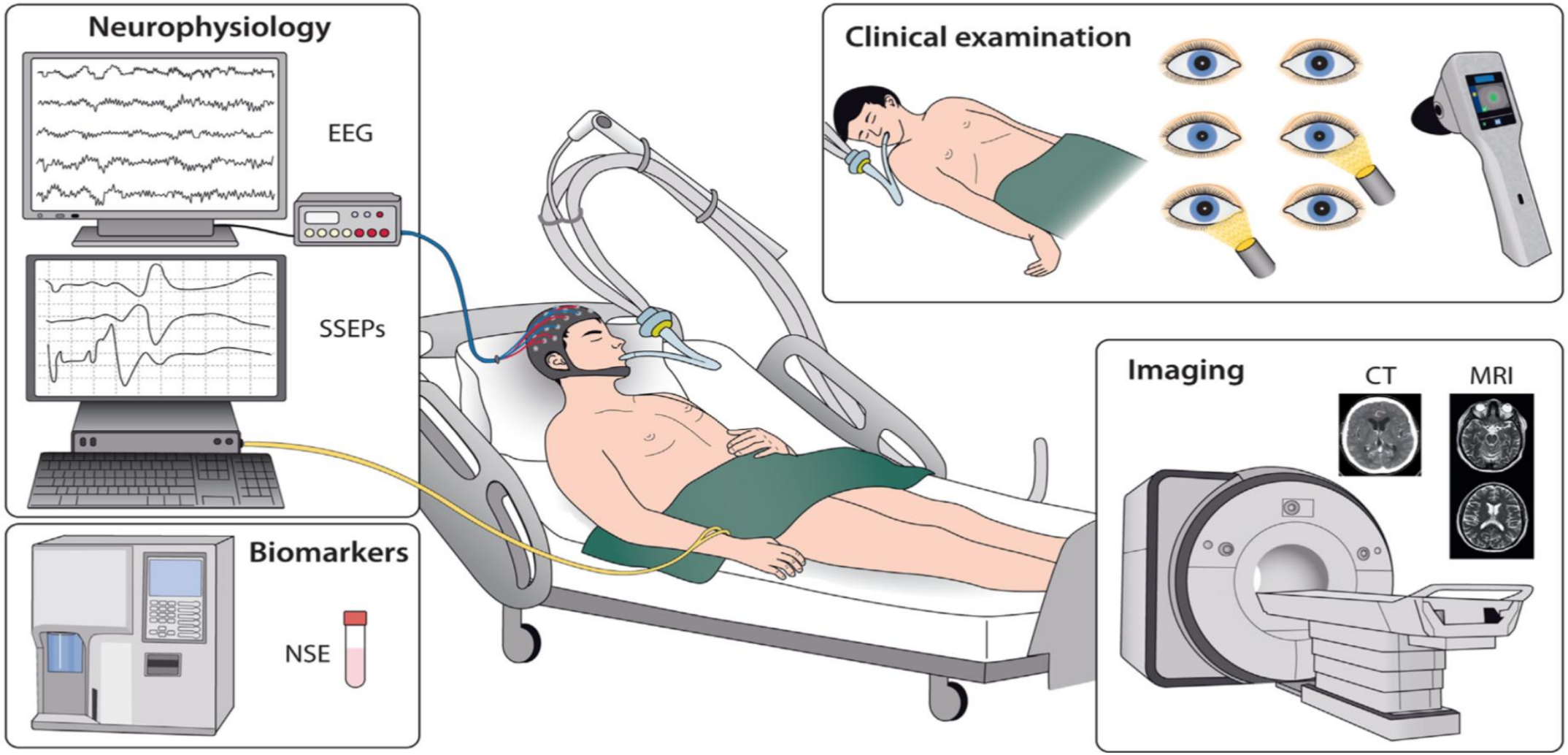


End Point	Immediate Angiography (N=265)	Delayed or Selective Angiography (N=265)	Effect Size (95% CI)†
Primary end point			
Death from any cause — no. (%)	143 (54.0)	122 (46.0)	Hazard ratio, 1.28 (1.00 to 1.63)
Secondary efficacy end points‡			
Myocardial infarction — no./total no. (%)	0/248	2/250 (0.8)	Relative risk, 0 (0 to 1.93)
Severe neurologic deficit — no./total no. (%)§	21/112 (18.8)	16/126 (12.7)	Relative risk, 1.48 (0.82 to 2.67)
Death from any cause or severe neurologic deficit — no./total no. (%)	164/255 (64.3)	138/248 (55.6)	Relative risk, 1.16 (1.00 to 1.34)
Median length of ICU stay (IQR) — days	7 (3–11)	8 (4–13)	HLE, −1 (−2 to 0)

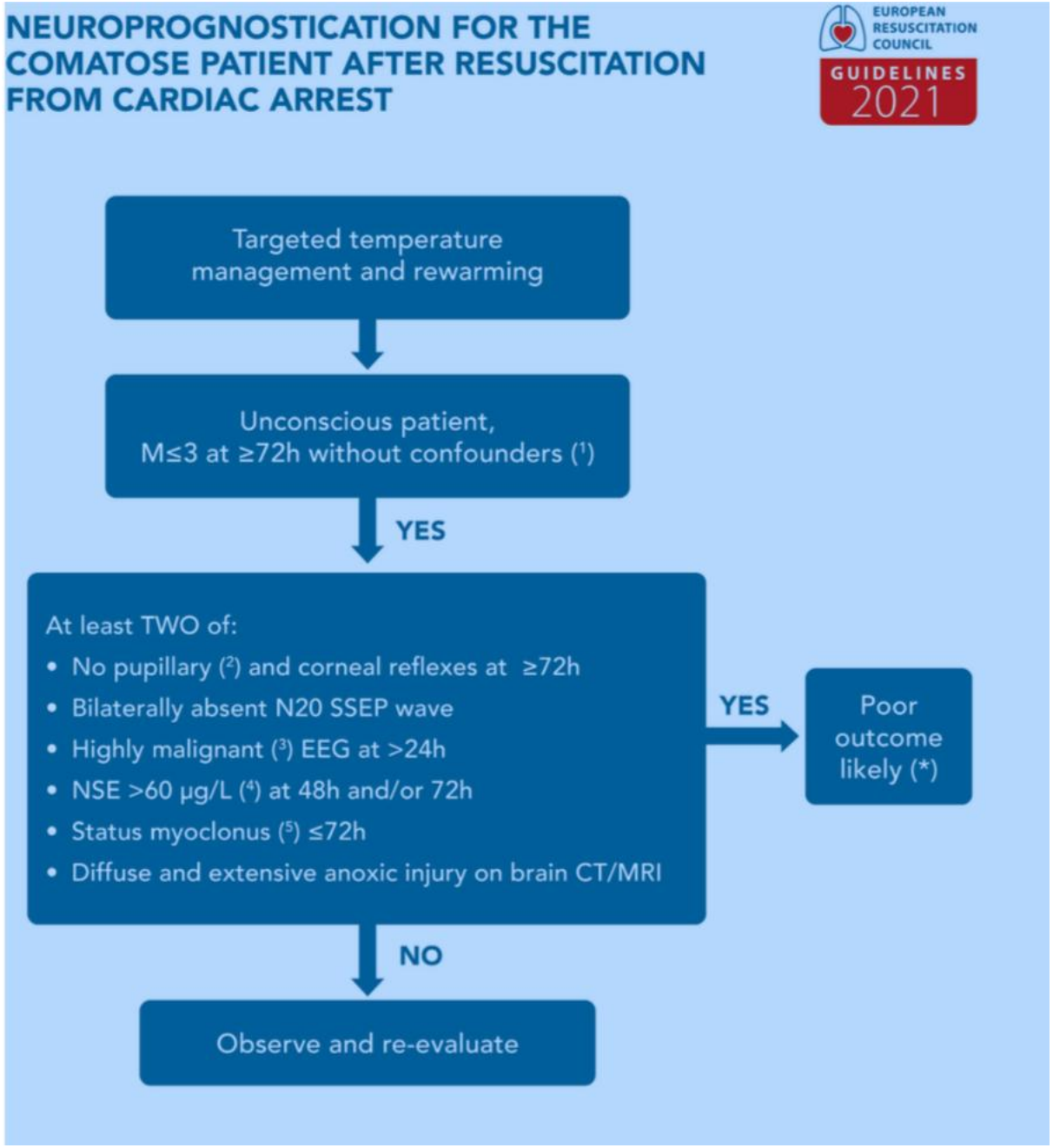
Diagnostický algoritmus



Neuroprognostifikace



- Klinická : GMS, pupilární rf., korneální rf., myokolonus
- Elektrofyziologie: EEG, SSEP
- Biomarkery: NSE 24, 48 a 72 hod.
- Zobrazovací metody: CT/MRA



The NEW ENGLAND JOURNAL of MEDICINE
ORIGINAL ARTICLE

Randomized Trial of Three Anticonvulsant Medications for Status Epilepticus

The NEW ENGLAND JOURNAL of MEDICINE

Trial of Three Anticonvulsant Medications for Status Epilepticus

MULTICENTER, RANDOMIZED, DOUBLE-BLIND TRIAL

384
Children and adults with benzodiazepine-refractory status epilepticus

	Levetiracetam	Fosphenytoin	Valproate
	60 mg/kg	20 mg/kg (phenytoin equivalents)	40 mg/kg
Absence of clinically evident seizures and improved responsiveness at 60 min	47% (68/145)	45% (53/118)	46% (56/121)

Outcome	Levetiracetam (N=150)	Fosphenytoin (N=125)	Valproate (N=125)
	number of patients (percent)		
Life-threatening hypotension within 60 min after start of trial-drug infusion	1 (0.7)	4 (3.2)	2 (1.6)

VŠEOBECNÁ FAKULTNÍ NEMOCNICE V PRAZE

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The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Treating Rhythmic and Periodic EEG Patterns in Comatose Survivors of Cardiac Arrest

B.J. Ruijter, H.M. Keijzer, M.C. Tjepkema-Cloostermans, M.J. Blans, A. Beishuizen, S.C. Tromp, E. Scholten, J. Horn, A.-F. van Rootselaar, M.M. Admiraal, W.M. van den Bergh, J.-W.J. Elting, N.A. Foudraine, F.H.M. Kornips, V.H.J.M. van Kranen-Mastenbroek, R.P.W. Rouhl, E.C. Thomeer, W. Moudrous, F.A.P. Nijhuis, S.J. Booij, C.W.E. Hoedemaekers, J. Doorduin, F.S. Taccone, J. van der Palen, M.J.A.M. van Putten, and J. Hofmeijer, for the TELSTAR Investigators*

TELSTAR

- 172 pt. comatose after OHCA/IHCA
- rhytmic and periodic EEG patterns on continous EEG (start at least H24)
- CRT 1:1, 88 pts. antiseiuzere med. vs. 84 pts. standard care
- Therapy et least 48 hours
- Primary outcome : CPC at 3 months
- Secondary endpoints: mortality, ICU stay, MV days
- Interventions:
- STEP 1- first antiseizure drug (phenytoin/valproate/levetiracetam)+ sedative (propofol or midazolame)
- STEP 2 – second antiseizure drug+second sedative
- STEP 3 – high dose barbiturate

VŠEOBECNÁ FAKULTNÍ NEMOCNICE V PRAZE

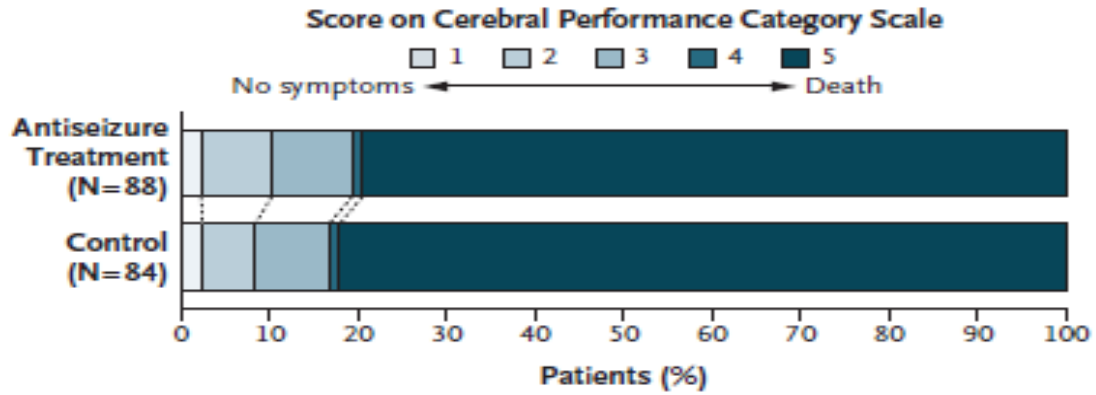
1. LÉKAŘSKÁ FAKULTA Univerzita Karlova

Table 2. Antiseizure Treatment and EEG Response.*

Variable	Antiseizure Treatment (N=88)	Control (N=84)†
	no./total no. (%)	
Treatment details		
Intensive antiseizure treatment started	88/88 (100)	0/83
Intensive antiseizure treatment continued after 24 hr‡	54/88 (61)	0/83
No. of antiseizure drugs used		
0	0/88	75/83 (90)
1	24/88 (27)	5/83 (6)
2	57/88 (65)	3/83 (4)
≥3	7/88 (8)	0/83
No. of sedative drugs used		
0	1/88 (1)	20/83 (24)
1	27/88 (31)	47/83 (57)
2	54/88 (61)	15/83 (18)
≥3	6/88 (7)	1/83 (1)
≥1 Antiseizure drug continued during entire period of ICU admission	85/88 (97)	8/83 (10)
Effect on EEG recordings		
Complete suppression of EEG index activity for ≥48 consecutive hr§	49/88 (56)	2/83 (2)
Complete suppression of EEG index activity for ≥24 consecutive hr	75/88 (85)	10/83 (12)
Suppression of RPPs 0–24 hr after randomization		
Complete	64/88 (73)	3/83 (4)
Partial	20/88 (23)	11/83 (13)
None	4/88 (5)	69/83 (83)
Suppression of RPPs 24–48 hr after randomization‡		
Complete	60/88 (68)	39/83 (47)
Partial	12/88 (14)	14/83 (17)
None	6/88 (7)	9/83 (11)
No EEG recordings available	2/88 (2)	1/83 (1)
Treatment restrictions during ICU admission		
Do not resuscitate	32/88 (36)	36/83 (43)
Withdrawal of life-sustaining treatment	68/88 (77)	65/83 (78)

Table 3. Primary, Secondary, and Safety Outcomes (Intention-to-Treat Population).*

Outcome	Antiseizure Treatment (N=88)	Control (N=84)	Measure of Effect†		P Value
			Calculation	Value (95% CI)	
Primary outcome					
CPC score of 3, 4, or 5 at 3 mo — no. (%)	79 (90)	77 (92)	Risk difference	2 (–7 to 11)	0.68
Secondary outcomes‡					
CPC score at 3 mo§			Common odds ratio	1.19 (0.56 to 2.53)	
CPC score of 2 to 5 at 3 mo — no. (%)	86 (98)	82 (98)	Risk difference	0 (–5 to 4)	
CPC score of 4 or 5 at 3 mo — no. (%)	71 (81)	70 (83)	Risk difference	3 (–9 to 14)	
Death at 3 months — no. (%)	70 (80)	69 (82)	Risk difference	3 (–9 to 14)	
Mean length of stay in the ICU (95% CI) — days	8.7 (6.7 to 10.7)	7.5 (5.5 to 9.4)			
Mean duration of mechanical ventilation (95% CI) — days	7.8 (6.1 to 9.5)	6.6 (4.9 to 8.4)			
Serious adverse events until 3 mo					
Any serious adverse event — no. (%)	73 (83)	72 (86)	Chi-square test		0.62
Death after withdrawal of life-sustaining treatment — no./total no. (%)	68/88 (77)	65/83 (78)	Chi-square test		0.87
Death, other cause — no. (%)	2 (2)¶	4 (5)‖	Fisher's exact test		0.44
Patients with other serious adverse events — no. (%)	8 (9)	9 (11)	Chi-square test		0.72
No. of other serious adverse events	10	11			

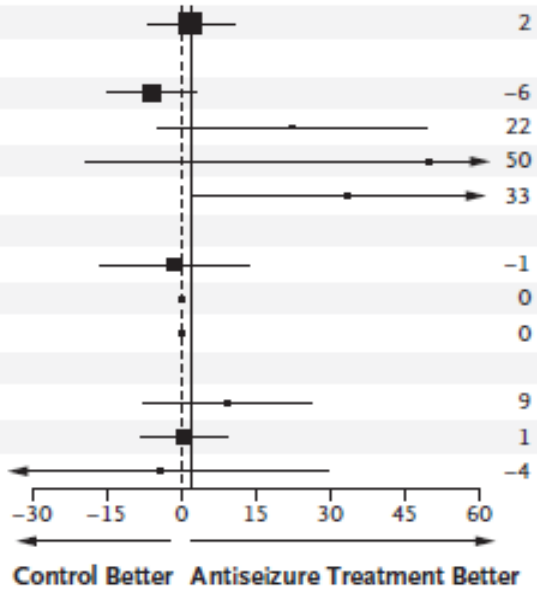


GDP:

Generalized periodic discharges

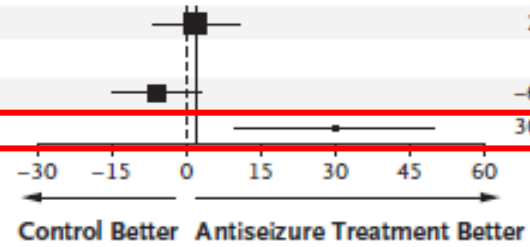
A Prespecified Analyses

Subgroup	Control (no. of patients with good outcome/total no. (%))	Antiseizure Treatment (no. of patients with good outcome/total no. (%))	Difference (95% CI) (percentage points)
Overall	7/83 (8)	9/88 (10)	2 (–7 to 10)
Type of rhythmic and periodic activity			
GPDs, 0.5–2.5 Hz	7/67 (10)	3/68 (4)	–6 (–15 to 3)
Electrographic seizures, ≥2.5 Hz	0/8	2/9 (22)	22 (–5 to 49)
Evolving patterns, 0.5–2.5 Hz	0/3	1/2 (50)	50 (–19 to 119)
Other, 0.5–2.5 Hz	0/5	3/9 (33)	33 (2 to 64)
EEG background continuity			
Continuous	7/40 (18)	9/56 (16)	–1 (–17 to 14)
Discontinuous	0/29	0/19	0 (0 to 0)
Suppressed	0/14	0/13	0 (0 to 0)
Onset of rhythmic and periodic activity			
<24 hr after cardiac arrest	0/19	1/11 (9)	9 (–8 to 26)
24–48 hr after cardiac arrest	3/51 (6)	4/62 (6)	1 (–8 to 10)
>48 hr after cardiac arrest	4/13 (31)	4/15 (27)	–4 (–38 to 30)



B Post Hoc Analysis: GPDs vs. Non-GPD Patterns

Subgroup	Control (no. of patients with good outcome/total no. (%))	Antiseizure Treatment (no. of patients with good outcome/total no. (%))	Difference (95% CI) (percentage points)
Overall	7/83 (8)	9/88 (10)	2 (–7 to 10)
Type of rhythmic and periodic activity			
GPDs, 0.5–2.5 Hz	7/67 (10)	3/68 (4)	–6 (–15 to 3)
Non-GPD patterns	0/16	6/20 (30)	30 (10 to 50)



CAC

Adult patients with non-traumatic OHCA should be considered for transport to a cardiac arrest centre according to local protocol.	An expert consensus paper published by several European organisations including the Association of Acute Cardiovascular Care (ACVA) of the European Society of Cardiology (ESC), the ERC and the ESICM, states that the minimum requirements for a cardiac arrest centre are 24/7 availability of an on-site coronary angiography laboratory, an emergency department, an ICU, imaging facilities, such as echocardiography, CT, and MRI.[16] Based on evidence from a systematic review, ILCOR suggests that wherever possible, adult patients with non-traumatic OHCA cardiac arrest should be cared for in cardiac arrest centres.[17]

eCPR

Extracorporeal CPR (eCPR) is defined by the ELSO (Extracorporeal Life Support Organization) as the application of rapid-deployment veno-arterial extracorporeal membrane oxygenation (VA-ECMO) to provide circulatory support in patients in whom conventional CPR is unsuccessful in achieving sustained ROSC.[361] The use of eCPR has increased for both IHCA and OHCA in recent years.[362–365]

The 2019 ILCOR CoSTR informed by a systematic review made the following recommendation:[242,244,366]

- We suggest that eCPR may be considered as a rescue therapy for selected patients with cardiac arrest when conventional CPR is failing in settings in which it can be implemented (weak recommendation, very low certainty of evidence).

VŠEOBECNÁ FAKULTNÍ NEMOCNICE V PRAZE

1. LÉKAŘSKÁ FAKULTA Univerzita Karlova

Advanced reperfusion strategies for patients with out-of-hospital cardiac arrest and refractory ventricular fibrillation (ARREST): a phase 2, single centre, open-label, randomised controlled trial

Demetris Yannopoulos, Jason Bartos, Ganesh Raveendran, Emily Walser, John Connett, Thomas A Murray, Gary Collins, Lin Zhang, Rajat Kalra, Marinos Kosmopoulos, Ranjit John, Andrew Shaffer, R J Frascone, Keith Wesley, Marc Conterato, Michelle Biros, Jakub Tolar, Tom P Aufderheide

	ECMO-facilitated resuscitation (n=15)		Standard ACLS treatment (n=15)		Risk difference or p value
	Number of patients with data	Patients	Number of patients with data	Patients	
Primary outcome (95% CrI)					
Survival to hospital discharge	14	6 (43%, 21·3–67·7)	15	1 (7%, 1·6–30·2)	36% (3·7–59·2; posterior probability=0·9861)
Secondary outcomes (95% CI)					
Survival to 3 months	14	6 (43%, 21·3–67·7)	15	0 (0·0–20·4)	0·0063
Survival to 6 months	14	6 (43%, 21·3–67·7)	15	0 (0·0–20·4)	0·0063
CPC score at discharge	6	2·5 (0·5)	1	4	NA
CPC score at 3 months	6	1·16 (0·4)	0	NA	NA
CPC score at 6 months	6	1·16 (0·4)	0	NA	NA
mRS score at discharge	6	3·8 (0·7)	1	5	NA
mRS score at 3 months	6	2 (1·2)	0	NA	NA
mRS score at 6 months	6	1·3 (0·8)	0	NA	NA

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Effect of Intra-arrest Transport, Extracorporeal Cardiopulmonary Resuscitation, and Immediate Invasive Assessment and Treatment on Functional Neurologic Outcome in Refractory Out-of-Hospital Cardiac Arrest A Randomized Clinical Trial

Jan Belohlavek, MD, PhD; Jana Smalcova, MD; Daniel Rob, MD; Ondrej Franek, MD; Ondrej Smid, MD; Milana Pokorna, MD, PhD; Jan Horák, MD; Vratislav Mrazek, MD; Tomas Kovarnik, MD, PhD; David Zemanek, MD, PhD; Ales Kral, MD, PhD; Stepan Havranek, MD, PhD; Petra Kavalkova, PhD; Lucie Kompelentova, MD; Helena Tomková, MD; Alan Mejstrik, MSc; Jaroslav Valasek, MD; David Peran, MSc; Jaroslav Pekara, MSc; Jan Rulisek, MD, PhD; Martin Balik, MD, PhD; Michal Huptych, PhD; Jiri Jarkovsky, PhD; Jan Malik, MD, PhD; Anna Valerianova, MD, PhD; Frantisek Mlejnsky, MSc, PhD; Petr Kolouch, MD; Petra Havrankova, MD, PhD; Dan Romportl, MD; Arnost Komarek, PhD; Ales Linhart, MD, PhD; for the Prague OHCA Study Group

Table 2. Primary and Secondary Outcomes in a Study of Intra-arrest Transport, Extracorporeal Cardiopulmonary Resuscitation, and Immediate Invasive Assessment and Treatment in Refractory Out-of-Hospital Cardiac Arrest

	No. (%)			
	Invasive strategy (n = 124)	Standard strategy (n = 132)	Absolute difference, % (95% CI)	P value
Primary outcome				
Survival with minimal or no neurologic impairment at 180 d[a]	39 (31.5)	29 (22.0)	9.5 (−1.3 to 20.1)	.09
Secondary outcomes				
Survival with minimal or no neurologic impairment at 30 d[a]	38 (30.6)	24 (18.2)	12.4 (1.9 to 22.7)	.02
Cardiac recovery at 30 d[b]	54 (43.5)	45 (34.1)	9.4 (−2.5 to 21)	.12

Závěr

- Udržovat normoxémii a normokapnii
- Udržovat MAP na ne méně než 65 mmHg a diurézu nad 0.5 ml/kg/h
- TTM mezi 32-36°C po 24 h bez ohledu na IHCA/OHCA a inic. rytmus
- Paušálně akutně SKG u OHCA bez ST elevací neprovádět
- multimodální neuroprognostifikace/stanovení špatné neurol. prognózy
- Anitkonvulzivní terapie u epileptogenních projevů
- Zvážit možnost eCPR
- Směřování pacienta do CAC

My Lords, any state is better than despair. Let us at least make one effort; and if we must fall, let us fall like men!

After delivering this speech Chatham suddenly pressed his hand to his heart and fell back in a swoon.